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In This Issue

Photo Album—
Comet Arend-Roland

The Spectrum of Beta Lyrae

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Report

Comments on the Unusual
Tail of Comet Arend-Roland

Another Meteorite Crater
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Vol. XVI, No. 9 JULY, 1957

CONTENTS

COVER: This striking photograph of Comet 1956h (Arend-Roland) was taken on May 2-3, at midnight Eastern standard time, by a New York City amateur, Charles Cuevas, who had traveled to near Bethpage, Long Island, seeking a darker sky. He used an f/2.5 Aero-Ektar lens of 7-inch focal length for this unguided 20-second exposure on Kodak Royal-X Pan film. With binoculars, Mr. Cuevas estimated the comet's brightness as magnitude 3.5. (See pages 412 and 426.)

INTERNATIONAL GEOPHYSICAL YEAR BEGINS 411

PHOTO ALBUM — COMET AREND-ROLAND 412

THE SPECTRUM OF BETA LYRAE — Otto Struve 418

AMERICAN ASTRONOMERS REPORT 423

COMMENTS ON THE SUNWARD TAIL OF COMET AREND-ROLAND — Fred L. Whipple 426

ANOTHER METEORITE CRATER IN AUSTRALIA? — Ralph L. Sangster 429

BULLETIN FOR VISUAL OBSERVERS OF SATELLITES — No. 7 ..... Center

AMATEUR ASTRONOMERS 430
- Northeast Convention Is Held at New Haven
- Western Amateur Astronomers to Meet in Berkeley
- Further News About the Kansas City Convention

BOOKS AND THE SKY 435
- Spectroscopy at Radio and Microwave Frequencies
- The Milky Way
- New Horizons in Astronomy

GLEANINGS FOR ATM's 440
- Maksutov Telescope Notes
- How to Collimate a Refracting Telescope
- Collimating a Reflector in a Jiffy

NEWS NOTES 432

OBSERVER'S PAGE 446
- Observations of the May 5th Transit of Mercury
- Partial Solar Eclipse Observed in Northwest
- Deep-Sky Wonders

QUESTIONS 422

STARS FOR JULY 457

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International Geophysical Year Begins

ON JULY 1ST, when the International Geophysical Year formally begins, a multitude of scientific research programs will be started by 57 nations of the world. The United States will undertake many studies as its share in this largest co-operative scientific effort ever attempted. The IGY period will end on December 31, 1958, with some observing projects extending a month longer.

Besides the well-publicized earth satellite program, the American investigations are in the fields of meteorology, geomagnetism, aurora and airglow, ionospheric physics, solar activity, cosmic rays, longitudes and latitudes, glaciology, oceanography, upper atmosphere, seismology, and gravity. In addition, the U. S. National Committee is tentatively planning an expedition to the Pacific Ocean to observe the solar eclipse of October 12, 1958.

During the IGY there will be four types of world days or series of days on which special observing programs are to be scheduled: regular world days (RWD), alerts, special world intervals (SWI), and world meteorological intervals (WMI).

Regular world days will be the two consecutive days at new moon, as well as others near quarter phase and at times of expected prominent meteor showers (see page 319, May issue). On these days, observational activity will be increased in ionospheric physics, geomagnetism, and other fields.

In consultation with other countries, the National Bureau of Standards radio forecasting center at Ft. Belvoir, Virginia, will issue alerts, particularly when there is an unusually active region on the sun's disk, indicating a high probability of ensuing solar flares and geomagnetic disturbances. Alerts will also warn scientists that a special world interval may be called in a few days (by the IGY World Warning Agency), when there is a strong possibility that a significant geomagnetic disturbance will commence within the 24 hours following the start of the interval.

Each special world interval will require intensified work on ionospheric physics, geomagnetism, solar activity, cosmic rays, and the aurora. Some special cosmic ray balloon flights and rocket launchings will be made during these periods when conditions are favorable. The interval will be terminated when the disturbance has subsided, or in about 24 hours in case the expected disturbance does not materialize.

A world meteorological interval will last for 10 days, four times a year, including the solstice or equinox day and three regular world days. The rocket launchings are almost all scheduled for these intervals.

(*Continued on page 433*)

PHOTO ALBUM
Comet Arend-Roland

One of the most noteworthy sky events in years was the appearance of Comet 1956h as a conspicuous naked-eye object, seen in the northwestern heavens during the evenings of late April and early May. This six-page collection is a day-by-day sampling from the extensive photographic records secured by both amateur and professional astronomers in many countries.

Left: April 22-23, 1957, at 21:30 UT. R. Fogelquist, Uppsala, Sweden, took this early picture, a one-hour exposure with an f/4.5 lens of 4.7-inch focal length. Just two weeks after its closest approach to the sun, the comet shows a broad, bright sunward tail.

Above: April 24-25, 2:46 UT. At State College, New Mexico, C. F. Capen, Jr., and B. A. Smith used an Ektar K-24 camera mounted on a 7-inch reflector for this one-minute exposure, which gives the naked-eye aspect at that time.

Left: April 24-25, 0:00 UT. Another picture by Mr. Fogelquist, 50-minute exposure; in two days the sunward tail has narrowed and turned.

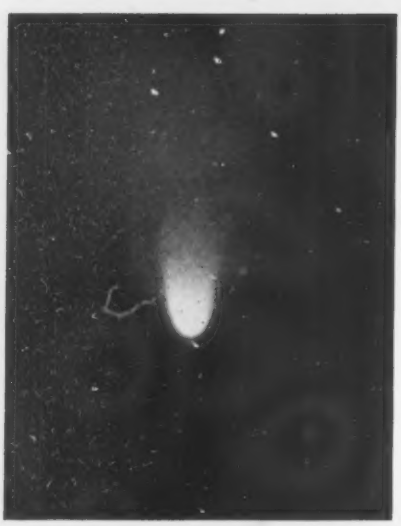
Upper left: April 25-26, 3:08 UT. At McDonald Observatory in Texas, G. Van Biesbroeck used the 82-inch reflector for this six-minute prime-focus photograph. The curious antitail, pointing sunward, is much narrower than in the preceding pictures, and its direction is now nearly opposite to that of the main tail.

Right: April 25-26, 3:05 UT. E. Mendoza and M. Krebs made this 20-minute exposure with the 10-inch refractor at McDonald Observatory. Taken nearly simultaneously with the 82-inch photograph on this page, this view is remarkable for the sharpness of the sunward spike, here some eight degrees long.

Lower left: April 25-26, 22:10 UT. When Mr. Fogelquist obtained this 90-minute exposure, with the same camera as before, the antitail was almost exactly edgewise, for the earth had passed through the plane of the comet's orbit only five hours earlier (see page 426). Note the fainter glow enveloping the sunward tail.

Above: April 26-27, about 5:30 UT. For this 5-minute exposure, Dr. W. S. Butts, Pullman, Washington, set his 100-mm. f/3.5 Ektar lens on an equatorial mount driven by the works of an alarm clock. The bright star $1\frac{3}{8}$ inches left of the head is Alpha Persei; Gamma Persei is $1\frac{3}{4}$ inches above the head. Compare this with the picture at the left and note the motion of Comet Arend-Roland during the two-hour interval between the two exposures.

Left: April 26-27, 3:38 UT. Much structure is visible in the main tail, and the spike, now slightly broadened, has continued its clockwise drift with respect to the main tail. H. L. Giclas used the Lowell Observatory's 13-inch refractor, exposure 21 minutes.



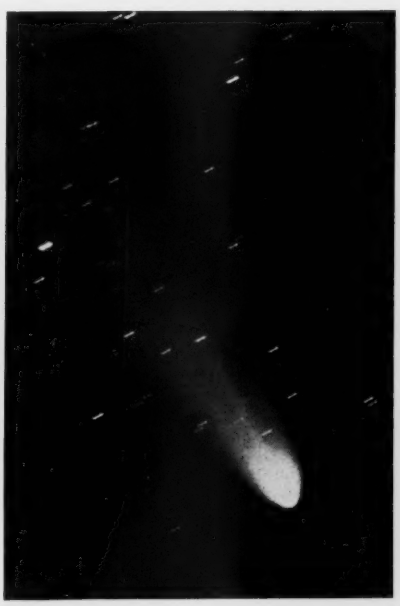
Above: April 26-27, 1:34 UT. Only the nucleus and head of Comet 1956h appear in a 30-second photograph by L. T. Johnson, Welcome, Maryland, at the Newtonian focus of his 16-inch reflecting telescope.

Left: April 26-27, 1:20 UT. This picture is also by Mr. Johnson with the 16-inch, but exposed five minutes. The inner main tail is embedded in a broader, faint sheath. The sunward tail has become much fainter.

Right: April 27-28, 2:53 UT. D. Krolikowski, Wausau, Wisconsin, used only the simplest means, a small hand-guided camera, for this 3.7-minute exposure, greatly enlarged.

Left: April 27-28, about 20:00 UT. At Grenchen, Switzerland, G. Klaus used an f/1.9 Praktika camera stationary on a tripod for this one-minute shot on Tri-X film. At this time Comet Arend-Roland was still a 3rd-magnitude object, with the spike fainter and broader. As on the night before (see facing page) one edge of the main tail was straight and fairly sharp, the other concave and indistinct.

Right: April 28-29. This picture was taken at Kitt Peak, Arizona, one of the sites undergoing seeing tests for the National Astronomical Observatory, and was transmitted by A. B. Meinel. The 70-minute exposure on Royal Pan film was made by C. Knuckles, with a Linhof 4-by-5 camera and a 135-mm. lens at f/3.8. The sunward tail is dimmer and broader, and turned still farther to the left.



April 29-30: Compare the scales of these three pictures, taken within an hour of each other. Left: At 1:52 UT, a small-scale 35-minute exposure with an f/3.8 portrait lens of 13 inches focal length, by J. B. Downs, Jr., and P. W. McEntire, Jacksonville, Florida. Center: At 2:42 UT, a closeup (scale four times that at the left) by Mr. Johnson with his 16-inch reflector, exposure 35 minutes. Right: A 10-minute exposure of medium scale, showing structure in the main tail, with a 3-inch Ross camera clamped on Mount Holyoke College's 8-inch refractor, by Misses K. Bracher and J. Gill.

Above: April 30-May 1, 2:37 UT. J. Labrecque, Rochester, New York, used an f/4.5 Baltar lens of 9-inch focal length, on a clock-driven equatorial mounting, for a 10-minute exposure on Comet 1956h.

Left: April 30-May 1. This is a 10x enlargement from another Mount Holyoke College photograph with the 3-inch camera, exposed 30 minutes, by Misses K. Bracher, C. Copson, and J. Gill. The main tail is a fan-shaped sheaf of rays, and the anomalous sunward tail has faded so much as to be only faintly indicated.

Left: April 30-May 1, 4:16 UT. The flashing light of an airplane moved across the comet's tail in this picture by T. A. Walsh, San Francisco, California. He used a 35-mm. Exacta camera, clamped to a 3-inch guide telescope. As he guided on a star during the exposure, the television antenna in the foreground appears blurred.

April 30-May 1, 2:14 UT. This 30-minute exposure was secured at the focal plane of an f/8, 6-inch reflector by J. H. Conklin, Mullica Hill, New Jersey, who guided on the comet.

Above: May 1-2. Another Mount Holyoke College view, enlarged from a 30-minute exposure with the 3-inch Ross patrol camera, taken by Misses C. Copson, E. Schultz, and S. Vaughn. The emulsion was Eastman 103a-B. Now rapidly receding from both the earth and the sun, the comet was nightly becoming a smaller and fainter object.

Above: May 2-3, 2:50 UT. C. Cuevas made this picture at Bethpage, New York, on the same night that he obtained the front-cover photograph. This 3-minute exposure was with an f/4.5 Kodak lens of 7½ inches focal length. Note that in this and other views on this page the left edge of the main tail has become sharper than the right, in contrast to the appearance several nights earlier.

Below: May 4-5, 4:11 UT. In this closing scene, the comet is shown just about to descend behind trees at Rochester, New York. Photograph by J. Labrecque, with a clock-driven f/4, 105-mm. Tessar lens, exposure 10 minutes.

Above: May 2-3, 13:50 UT. At Hong Kong, China, Mr. and Mrs. Hing-chai Liu used a portrait lens of 4-inch aperture and 16-inch focus. For the 50-minute exposure on Royal Pan film, their camera was temporarily mounted on a 6½-inch equatorial which served as a guide telescope.

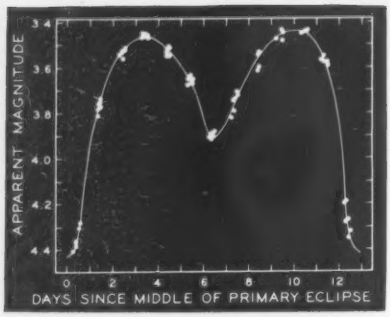


Fig. 1. The apparent brightness of Beta Lyrae changes continually as the component stars revolve around each other. The secondary minimum is in the middle of this photoelectric light curve, obtained by Joel Stebbins in 1915. After Lick Observatory "Bulletin" No. 277.

The Spectrum of Beta Lyrae

OTTO STRUVE, *Leuschner Observatory, University of California*

THE STUDY of the spectra of the stars began about 150 years ago, when Joseph Fraunhofer in Munich constructed the first spectroscope. Somewhat later, Gustav Kirchhoff at Heidelberg University explained how the spectral lines seen as bright emissions in the laboratory could appear as dark absorptions in the spectra of the sun and stars.

Today stellar spectroscopy is still an almost inexhaustible source of information concerning the physical properties of stars and nebulae. It is, in fact, one of the most fascinating branches of modern astronomy. Since it is relatively little known to the amateur, I shall try to explain this month how the spectroscopist goes about his work, using for my example the spectrum of the famous eclipsing double star, Beta Lyrae.

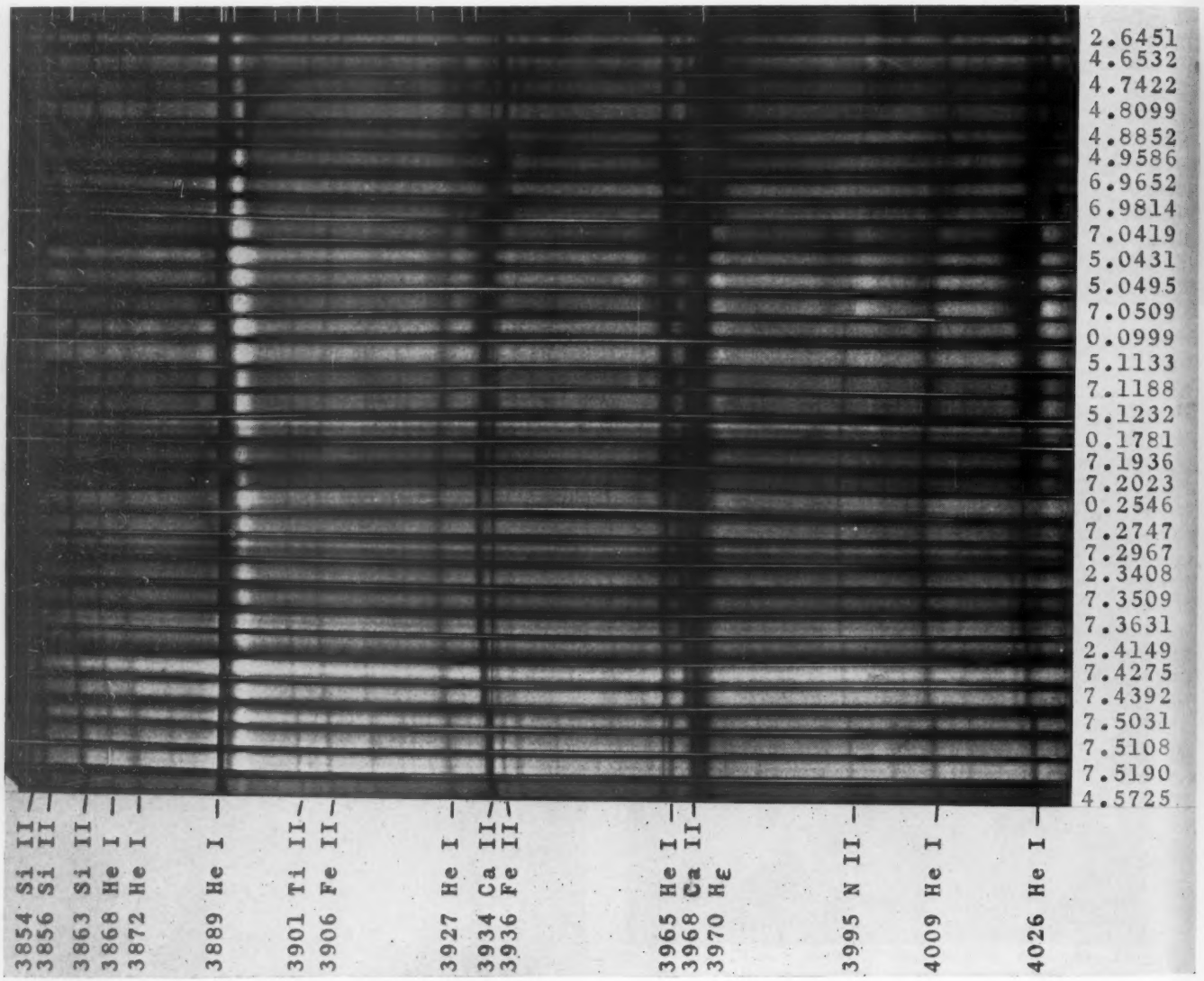


Fig. 2. Spectra of Beta Lyrae, made with the 100-inch reflector of Mount Wilson and Palomar Observatories, by Jorge Sahade and Otto Struve in 1955. The extreme violet region is shown here, including the H and K lines of calcium at 3968 and 3934 angstroms.

Situated a few degrees south of the brilliant summer star Vega, Beta Lyrae is normally of the third magnitude. It was known to the Arabs as Sheliak and to the ancient Chinese as part of the asterism Tsan-Tae, but apparently the early astronomers had not noticed that its brightness undergoes periodic changes. This fact was discovered in 1784 by John Goodricke, a deaf-mute amateur of York, England, who died two years later at the age of 22. After he had made a series of estimates of the brightness of Beta Lyrae by comparisons with its neighbor, Gamma Lyrae, Goodricke concluded that once every 6.5 days Beta Lyrae was fainter than its usual brightness.

Soon afterwards, however, he found that alternate minima of this variable star were of unequal depth. At one minimum the brightness declines by nearly a magnitude, at the succeeding one the fading is only half a magnitude (Fig. 1). The period was therefore double that first found, and, according to Goodricke, was 12 days 19 hours. Later observations have shown that the period is not constant, but has been steadily increasing at an average rate of about 10 seconds per year. Currently it is 12 days 22 hours 22 minutes.

Beta Lyrae consists of two stars that eclipse one another. Once in each 12.9-day cycle, when the smaller, fainter star passes in front of the bright, relatively large one, we observe the deeper (primary) eclipse. When the large star is in front, the secondary eclipse occurs.

At Mount Wilson Observatory during the summer of 1955, Dr. Jorge Sahade and I obtained nearly 200 spectrograms of Beta Lyrae, using a large spectrograph at the coude focus of the 100-inch reflecting telescope. In studying our results, our first step was to make enlarged prints of the individual spectra and to line them up, strip by strip, in their order in the 12.9-day cycle. Fig. 2 shows a

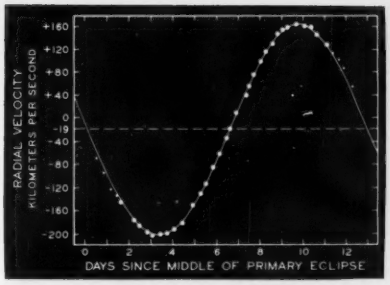


Fig. 3. R. A. Rossiter's velocity curve of the B8 star, drawn from measures of 601 spectrograms. The dashed line denotes the velocity of approach of the center of gravity of the system. The eight tiny dots are for phases at which the B8 star is partly eclipsed, so the effect of the star's rotation displaces these points from the curve. From the "Publications" of the Observatory of the University of Michigan.

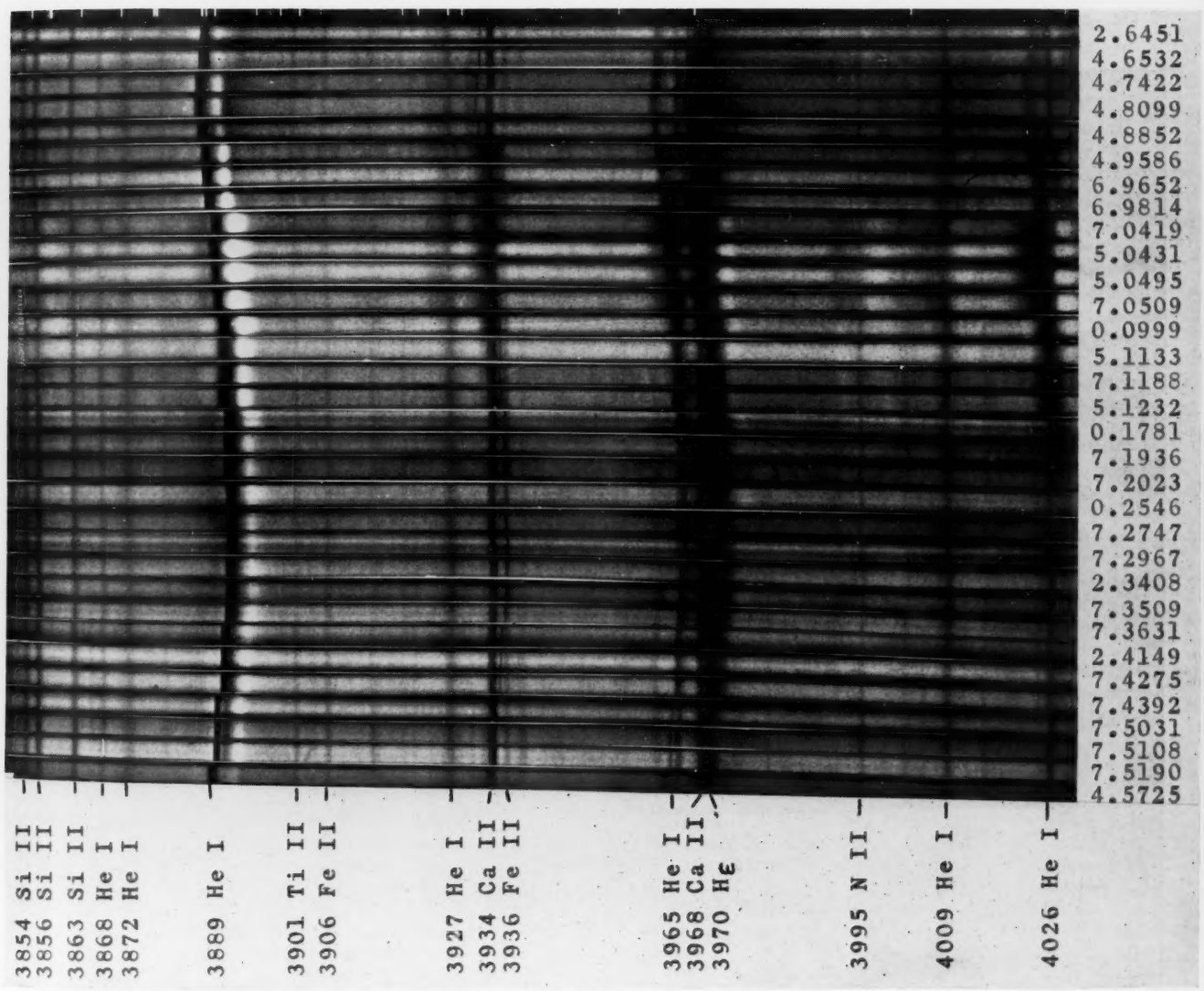


Fig. 4. These are the same spectra as in Fig. 2, but, instead of the interstellar lines of calcium, the absorption lines in the spectrum of the bright component have been used for vertical alignment.

selection from the extreme violet parts of the spectrograms, reproduced as positives —the black features are absorptions, the white ones emissions.

Near the middle of each spectrum in Fig. 2, there are two very narrow and sharp dark lines, at wave lengths 3934 and 3968 angstroms; they are produced by interstellar atoms of ionized calcium, and have been used to align the separate strips vertically.

The interstellar calcium lines are stationary in the spectrum, their wave lengths remaining unchanged by the motion of Beta Lyrae. Hence, by using them as reference marks, we can immediately detect the displacements of other absorption lines, caused by the orbital motion of the Beta Lyrae system. Notice how the images of the ionized silicon line at 3863 angstroms, for example, form a wavy curve from top to bottom. If we turn this illustration by 90 degrees, such lines appear to define something like a symmetrical sine curve.

On the right-hand margin of Fig. 2 the phases in the 12.9-day cycle are indicated for the individual spectrograms. The figure before the decimal point shows the serial number of the cycle, counted from an arbitrarily chosen date. The figures after the decimal point give the phase, with .0000 representing the middle of principal eclipse. Thus, 4.7422 for the third spectrogram from the top means it was taken in the fourth cycle, .7422 × 12.9 or about 9½ days after primary mid-eclipse.

What can we find out about the orbital motion from study of Fig. 2? Consider first the scale of the spectra. We measure the distance between the lines of wave lengths 3854 and 4026 as 172 millimeters. The difference between these wave lengths is 4026 − 3854 = 172 angstroms. Hence the scale of our reproduction is almost exactly one angstrom per millimeter. (On the original plates 10 angstroms occupy one millimeter.)

Now, notice the broad *stellar* line of ionized calcium at 3934; near phase .75 it is about 2.4 millimeters to the right (red) of the interstellar line, while at phase .25 it is the same distance to the left (violet). These shifts must be due to the fact that at phase .75 (9.7 days after mid-eclipse) the more luminous component star—whose spectrum we see—is receding from us, while at phase .25 (3.2 days after mid-eclipse) it is approaching us. The recession and approach each measure 2.4 millimeters on the illustration, or 2.4 angstroms.

The Doppler principle tells us that the recession of v kilometers per second equals 300,000 $\Delta\lambda/\lambda$. In our case, $\Delta\lambda$ = 2.4 and λ = 3934 angstroms. Therefore, the star is moving away from us at about 180 kilometers per second at phase .75, and is coming toward us with the same velocity at phase .25.

The orbital velocity of the brighter component of Beta Lyrae is thus 180 kilometers per second, with reference to the center of gravity of the system. Moving at this rate for 12.9 days (1.1 million seconds), the star travels 2 × 10^8 kilometers—the circumference of its orbit.

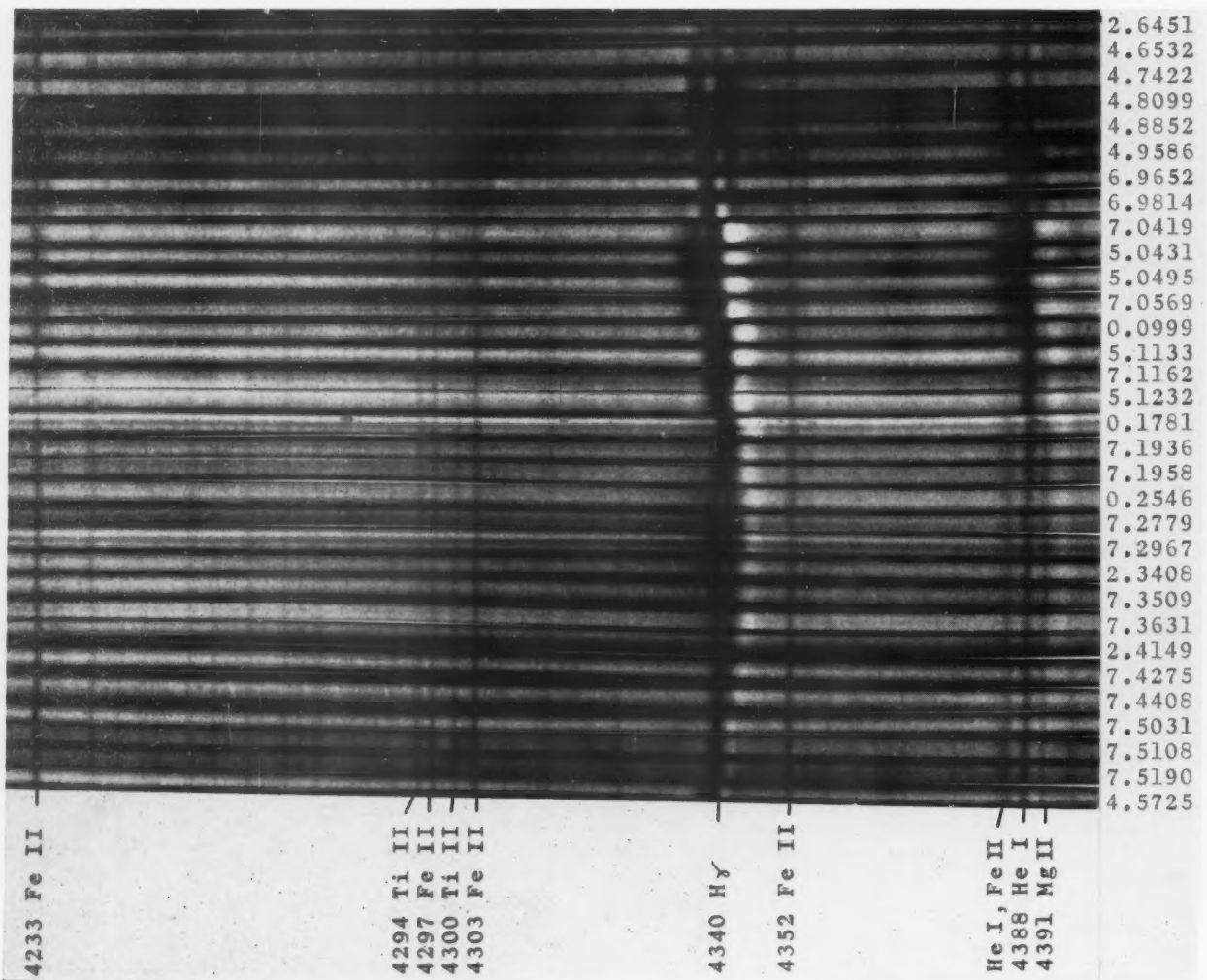


Fig. 5. These Beta Lyrae spectra by Jorge Sahade and Otto Struve are for a longer wave-length region than Fig. 4, but they have been aligned in the same manner, by using the absorption lines in the spectrum of the bright component.

The radius of the orbit is this number divided by 2π, or about 3×10^7. But the radius of the brighter star is known from the light curve to be some 5×10^7 kilometers. The center of mass is therefore located inside the star, more than halfway from its center toward the surface.

By making accurate measurements of the shift of the lines on all these spectra, and plotting the velocities against the phases, an astronomer obtains the velocity curve of Beta Lyrae. The fine curve reproduced in Fig. 3 was determined about 30 years ago by R. A. Rossiter at the University of Michigan. It is very nearly symmetrical—showing that the orbit is almost exactly a circle. Our spectrograms of 1955 give a still more accurate velocity curve, and S. S. Huang has recently used it to obtain the orbital elements of Beta Lyrae with the aid of the IBM 701 electronic computer in Berkeley, California.

But let us return to the spectra. When the bright star is coming toward us at phase .25, the faint component must be receding. Furthermore, at phase .75 the faint star is moving toward us. But the spectra in Fig. 2 show no lines forming a wave that is opposite in curvature to the lines already discussed. Evidently, the second component's spectral lines are invisible; this star is too faint to reveal itself on the spectrograms.

The absorption lines attributed to the brighter component of Beta Lyrae arise from hydrogen, helium, and ionized silicon, iron, calcium, nitrogen, magnesium, and titanium. From the relative intensities of the lines, the spectral type of this star is about *B*8, and its surface temperature is about 15,000° K. Because of the great size of the star—apparently some 70 times the sun's diameter—we may call it a supergiant.

We can find additional facts about Beta Lyrae by rearranging the spectra so that the absorption lines of the *B*8 supergiant form straight vertical patterns (Fig. 4). The lines of interstellar calcium now make a wavy pattern, but we note that this happens in some other cases, such as the helium lines at 3889 and 4026 angstroms. In Fig. 5, where the blue region of these spectra have been arranged as in Fig. 4, the hydrogen-gamma line at 4340 angstroms is also strongly curved, and does not follow the *B*8 orbital motion.

This Hγ line and the others like it must come from a large shell of gas enveloping the double star system; those parts of the shell that at any given phase are seen projected against the *B*8 star produce absorption lines. This shell cannot be attached to the *B*8 component, for then its lines would have the same velocity displacements as the star's lines. Instead, they always show a velocity of approach of roughly 100 kilometers per second—the shell is certainly expanding. But is this shell rotating around the center of gravity, or is it perhaps attached to the invisible small star?

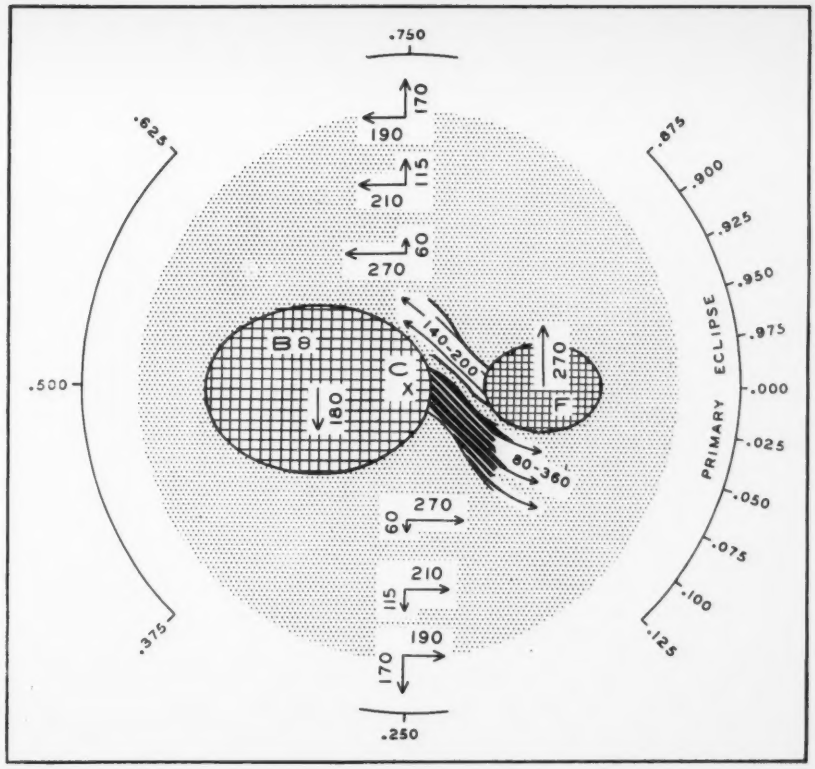


Fig. 6. The two components of Beta Lyrae are sketched here, elongated by each other's attraction, inside their gaseous envelope. Arrows for star and gas motions are labeled in kilometers per second. On the outer circular scale, the directions from the center of the system toward the earth are indicated for different phases, which correspond to the spectrum labels in Figs. 2, 4, and 5.

To answer these questions let us examine the emission lines, such as Hγ, in Fig. 5. Here the column of Hγ emission images shows a marked curvature, indicating that most of the emitting atoms are receding with respect to the *B*8 star at phase .25, while at phase .75 they have a small velocity of approach. At the former phase the emission lines are much stronger than at the latter. (They seem most intense at phase zero, but this is due to the longer exposures required to record the continuous spectrum of the *B*8 star during eclipse, when much of its disk is blotted out by the invisible companion.)

The waviness of the Hγ pattern in Fig. 5 indicates an orbital velocity of about 100 kilometers per second. Thus, the gas does seem to rotate in the system, but the shell is not attached to the invisible component, for the latter's orbital velocity is considerably greater, about 270 kilometers per second. Since the displacements of the emission lines are opposite in sense from those of the *B*8 star's lines, we infer that most of the gas is located on the opposite side of the center of gravity from that star. It revolves independently of the two stars, presumably in rather complicated orbits around the center of gravity of the system.

The total width of the Hγ emission in Fig. 5, measured between the extreme edges of the line, is about 10 millimeters. If we express this as a difference in radial velocities, we find that the fastest moving atoms have motions of approach and recession of the order of 350 kilometers per second—much faster than either star is moving. The individual orbits of the atoms, or clouds of atoms, are not known.

Some remarkable conclusions can be derived from an inspection of the absorption lines at phases between .0419 and .0569. At this time Hγ and several other lines have strong, broad absorption features. This means that a large number of rapidly approaching atoms are seen in front of the *B*8 star just after mid-eclipse, but not before it. We conclude that a dense, hot stream of gas leaves the surface of the *B*8 star and flows around the following hemisphere of the invisible star, which is marked *F* in Fig. 6. This stream is invisible before mid-eclipse because it is then eclipsed by the *F* star. After phase .0999 this absorption feature vanishes, and in its place there is a broad but feeble emission. Evidently, from this phase and until about phase .1232 the stream is no longer in front of the *B*8 star; it is projected against the *F* star and the space between the two stars, so the stream produces emission lines displaced toward the violet. In Fig. 6 the thick lines representing this stream are marked 80-360, to

show the range of velocities involved, in kilometers per second.

What becomes of this stream of gas? We cannot tell from observation, but evidently the gas must fill a very large volume surrounding the two stars, and some of it escapes to merge ultimately with the interstellar gas. Calculations by G. P. Kuiper, Yerkes Observatory, show that the orbital motion of the stream is probably along a vast spiral, as in Fig. 7.

There is also another, cooler stream of gas revealed by the spectrograms. From phase .9586 to .9814, this stream produces red-displaced absorption components of the helium line 4026, hydrogen-gamma, and other lines. At mid-eclipse these absorptions suddenly vanish; the stream is then mostly hidden by the invisible *F* star, and no part of it is projected against the disk of the *B*8 star. But for a short interval, from phase .0419 to .0509, the outermost fringes of this second stream are still visible against the sky background. This explains why the red-displaced absorption lines are suddenly replaced by emission features at phase .0419.

The model of Beta Lyrae pictured in Fig. 6 will account for all the phenomena discussed above, but the spectra show many other enigmatic features. The stellar spectroscopist spends many hours examining such puzzles on his spectrograms, recording and sometimes measuring them, and trying to modify his model to account for them. Several of these as yet unexplained problems are of particular interest.

Note in Fig. 2 how the 3889 line at phases .7422, .8099, and .8852 has a shaded absorption on the red side of the red-displaced emission feature. The 3889 line is a blend of helium and hydrogen-epsilon. The very strong, sharp absorption line and the strong emission are produced mostly by helium atoms located far above the photosphere of the *B*8 star. It is possible that the shaded absorption we have mentioned is due to hydrogen. You can see such a redward absorption wing for the hydrogen-gamma line also at about phase .75 by looking at Fig. 5. At this phase, the *B*8 component is receding, and the hydrogen wings should stick well out beyond the complicated structure of absorption and emission produced by the shell.

But the presence of such broad wings in the supergiant *B*8 star comes as a surprise. Other supergiants, like Rigel and Deneb, do not show them; the wings are characteristic of such less luminous stars as Sirius and Vega. It would appear, therefore, that Beta Lyrae is not especially luminous; its visual absolute magnitude may be only −4 instead of −7.6 as suggested by Kuiper. But this would mean, according to the mass-luminosity law, that the mass of the *B*8 star is only about 13 suns; the mass of the invisible *F* star must then be 21 suns to account for the large 180-kilometer-per-second orbital velocity

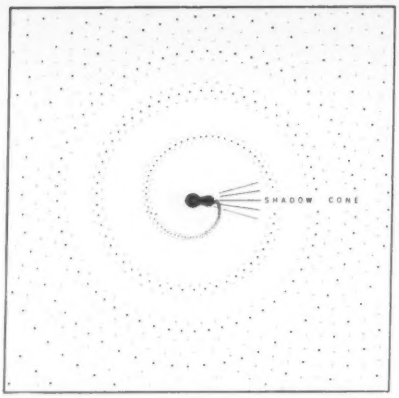


Fig. 7. As gas streams out from Beta Lyrae, the orbital motion of the binary causes the latter to wind itself in its own streamer, much like a giant pinwheel, according to the computations of G. P. Kuiper. Here the system of Beta Lyrae is viewed from above its plane. The fainter star shades the region marked "shadow cone."

of the brighter component of the system.

It seems improbable that the invisible component can really be so much more massive than the brighter star—in almost every case, the more luminous a star is, the greater is its mass. Perhaps the explanation is that the *B*8 star fails to obey the mass-luminosity relationship.

A second puzzle is provided by the intensities of certain absorption lines of the *B*8 star. Near phase .50 (secondary eclipse), the lines 4233, 4303, and 4352 of ionized iron are stronger than at any other time in the cycle. Very little if any strengthening of helium lines can be detected at this phase. Why are the lines of ionized iron, as well as calcium, magnesium, and silicon, stronger then, but not helium? The eclipse of the cooler *F* star by the *B*8 star has the opposite effect.

One answer to this riddle may be that the spectral type of the brighter star is not the same all around its surface; the hemisphere we observe at secondary eclipse may be cooler than the hemisphere turned toward us at primary eclipse. Another solution may be that the opacity of the shell through which we observe the *B*8 surface is smaller at phase .50 than at other times. A third conjecture is that the cool stream of gas from the *F* star flows along the following hemisphere of the *B*8 star, producing an accumulation of metallic atoms in front of it at phase .50. This could be illustrated by extending the arrows marked 140-200 in Fig. 6.

Another problem of Beta Lyrae involves the size of the bright star. As already mentioned, the light curve indicates that its radius is about 70 times the sun's. However, there is a rather compelling reason for believing it is much smaller than this. It is reasonable to suppose that the period of axial rotation of the *B*8 star is the same as the length of its orbital revolution. Then, if the star were 70 times larger than the sun, its equatorial velocity of rotation would be about 300 kilometers per second. But the absorption lines of the *B*8 star are only slightly widened by rotation, and measurements of the broadening suggest a rotational velocity of about 50 kilometers per second. This means that the radius of the star is only 1/6 of what we have assumed, say 12 times that of the sun—or that rotation and revolution are not synchronous. The former alternative is not incompatible with the assumption that the *B*8 star is less massive than the invisible *F* star.

A partial compromise has been suggested by S. Gaposchkin, of Harvard Observatory. He assumes that the mass of the brighter star is actually only half that of the *F* star. To avoid a violation of the mass-luminosity relation, he proposes that the *F* star is camouflaged by the gaseous streams, which dim its light. On his model, the *B*8 star has 19 times the sun's radius, giving, in the case of synchronization, a rotational velocity of 80 kilometers per second. This is still too large, but the discrepancy is not serious.

But puzzles remain in Gaposchkin's model. Why do the gas streams camouflage only the *F* star, and not the *B*8 star when the latter is observed through them just before and after the middle of principal eclipse? And how does the gas cut down the brightness of the *F* star 15-fold or more without observable re-emission of the absorbed energy?

QUESTIONS... FROM THE S+T MAILBAG

Q. Which is the largest satellite in the solar system?

A. Titan, Saturn's brightest moon, is about 3,100 miles in diameter, making it larger than the planet Mercury (3,010 miles). Jupiter's satellites Ganymede and Callisto, at 3,070 and 2,910 miles, are close rivals to Titan. All these diameters are uncertain by a few per cent, because of the difficulties of measurement.

Q. Is the magazine *Popular Astronomy* still published?

A. This journal ceased publication in December, 1951, with the close of volume 59. Files of this excellent magazine can be found in most large public libraries; it is worth looking up, as it contains many interesting articles for amateurs.

Q. Why must observers of total eclipses of the sun often travel so far to see this phenomenon?

A. Because the moon's shadow is very small where it strikes the earth (at most roughly 200 miles wide), and only within the path traveled by this very narrow shadow can the eclipse be seen as total. At places outside the shadow path the sun is eclipsed only partially, and the solar corona cannot be seen. W. E. S.

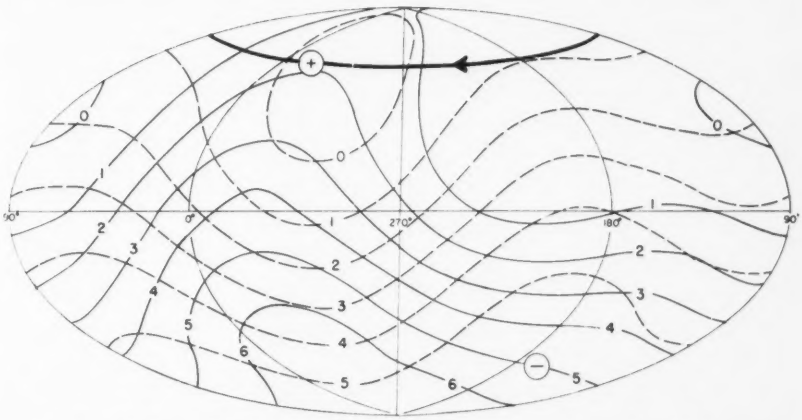
AMERICAN ASTRONOMERS REPORT

Here are highlights of some papers presented at the 97th meeting of the American Astronomical Society at Cambridge, Massachusetts, in May. Complete abstracts will appear in the Astronomical Journal.

Mapping a Star's Surface

Although the magnetic variable star HD 125248 is more than twice as large as the sun, at its distance from us of some 400 light-years it appears about as large as a dime 500 miles away. Like all the other stars beyond the sun, this star appears as a mere pinpoint of light, and no telescope can show its surface. Yet a map of the distribution of certain chemical elements on the star's photosphere has been prepared by Armin J. Deutsch, Mount Wilson and Palomar Observatories.

The method makes use of the remarkable periodic changes in the spectrum of HD 125248, a 6th-magnitude star in Virgo. There are abnormally strong lines of the rare-earth elements gadolinium, cerium, and europium, which vary in intensity in a period of 9.3 days. Other absorption lines, of iron, titanium, and chromium, change in conspicuousness in the same period, but reach their greatest intensities at a different phase in the 9.3-day cycle. Concurrently with their changes in strength, the spectral lines show small wave-length alterations. Furthermore, observations by H. W. Babcock, also at Mount Wilson and Palomar, reveal that the star has a strong magnetic field, which changes from positive to negative and back in the same 9.3-day period.



On this Aitoff equal-area projection, representing the entire surface of the star HD 125248, Armin J. Deutsch has plotted contour lines to show the probable distribution of certain elements. The full curves indicate constant local equivalent width for the rare-earth spectral lines; the dashed curves are for the chromium and strontium lines. The unit of equivalent width is the average strength of a line over the whole cycle of variation. The subsolar point describes the heavy curve in the direction indicated. Plus and minus signs mark the axis of the magnetic dipole of the star's general magnetic field. Mount Wilson and Palomar Observatories diagram.

These rhythmic changes can be explained by supposing that large "chemical spots" are carried across the star's disk by a rotation that takes nine days. Dr. Deutsch assumes that the star rotates as a rigid body, carrying its magnetic field with it. He has drawn a first tentative map of the largest features of the photosphere of HD 125248, based on high-dispersion spectrograms obtained with the 100-inch telescope on 13 nights.

According to this chart, the atoms of

Left: Dr. E. Margaret Burbidge is an English astronomer now on the staff of the Kellogg Radiation Laboratory, at California Institute of Technology. Here she talks with Dr. and Mrs. G. de Vaucouleurs, of France. He is the well-known expert on Martian problems. After a research visit to Mount Stromlo Observatory in Australia, Dr. de Vaucouleurs is now at the Lowell Observatory, Flagstaff, Arizona.

Right: Dr. A. Velghe, of the Royal Observatory at Uccle, Belgium, is seen here just before his recent return to Europe. He had been in the United States for galactic research at Harvard Observatory and at Warner and Swasey Observatory.

all the metals are concentrated toward one magnetic pole. Atoms of chromium and strontium spread out from this pole over one great "continent" which reaches down past the star's equator. Atoms of europium and certain other rare earths appear to define another large "continent" about 180 degrees in longitude from the first.

Three astronomers from widely separated observatories discussed their mutual problems at the reception in the Harvard Observatory library. They are, left to right: Dr. Carl K. Seyfert, director of Dyer Observatory, Nashville, Tennessee; Dr. Nicholas U. Mayall, Lick Observatory, Mt. Hamilton, California; and Dr. James G. Baker, Harvard Observatory research associate.

The reasons for this nonuniform distribution of chemical elements are not known, but presumably they are related to certain nuclear processes that take place in the star's atmosphere under the influence of the powerful magnetic field. The field may also hinder diffusion that would tend to blur out the regions of distinctive chemical composition.

Transparency of Saturn's Rings

The rare occasions when the ring system of Saturn passes in front of a star can provide useful information on the sizes and arrangement of the small bodies that comprise the rings. Two such occultations of stars by the rings, in 1917 and 1920, have been analyzed by A. F. Cook and F. A. Franklin, of Harvard Observatory. In addition, they re-examined the observations made by E. E. Barnard with the Lick 12-inch refractor on November 1, 1889, when the satellite Iapetus was eclipsed by the ring system—a unique occurrence.

From this discussion, it appears that the outermost ring, A, is comparatively transparent, while the inner region of the middle ring, B, blocks out about 40 per cent of light passing perpendicularly through it. Furthermore, some flickering of the star when behind ring B was noted during the 1920 occultation, with one nearly complete fadeout. This may possibly have been due to the finite size of the ring particles, in which case an upper limit of about five kilometers could be suggested for their diameters.

The two Harvard astronomers are analyzing observations of the occultation of an 8th-magnitude star by Saturn on April 28th of this year, of which some reports are given on page 448 of this issue.

Size of the Galaxy

"The problem of the scale of the galaxy is one of obvious importance, and currently appears to be particularly on the minds of astronomers," said Peter van de Kamp, of Sproul Observatory, who was one of six speakers at the May 10th conference on this subject, sponsored by the National Science Foundation.

Dr. van de Kamp called attention to the work of the Charlottesville conference, which was reported by Bart J. Bok in this magazine in June, 1956 (page 345), and pointed out particularly the need for greater accuracy in trigonometric parallaxes of nearby stars—a fundamental step toward finding the size of the galaxy.

At present the generally used value of the distance from the sun to the center of the Milky Way galaxy is 8,200 parsecs (about 27,000 light-years), from two accordant determinations. One of these was by Walter Baade in 1953, using the apparent brightnesses of 36 RR-Lyrae-type variable stars nearly in the direction of the galactic nucleus. The other result came from an analysis by Dutch radio astronomers in 1954 of the rotation of the galaxy, as indicated by interstellar neutral hydrogen clouds.

A critical examination of both results revealed that they may be more uncertain than is often supposed, the conference was told by Harold Weaver, of Leuschner Observatory. Both methods are indirect, he pointed out, and are affected in an involved manner by uncertainties in the intrinsic brightnesses of stars and in the amount of dimming of starlight by interstellar dust.

For example, Baade in his 1953 work believed that the absolute magnitude of the variable stars used had a mean error of ±0.2 magnitude, which by itself could affect his distance determination by 10 per cent. When other sources of error

Members and guests at the 97th meeting of the American Astronomical Society, May 8-11, 1957, at Harva

are taken into account, Dr. Weaver said, the uncertainty of the method employed by Baade must, at present, be at least as great as 1,000 parsecs, and may be much greater.

The speed of rotation of the galaxy in the sun's vicinity, which is a factor in interpreting the radio observations, may be larger than the usually cited values of around 200 kilometers per second, Dr. Weaver believes. The inconsistency which thus appears in our picture of galactic rotation could be removed if the sun were farther from the center of our Milky Way system than generally accepted, he suggested.

Another conference speaker was Maarten Schmidt, a Carnegie fellow at Mount Wilson and Palomar Observatories, who discussed the distribution of neutral hydrogen gas inside our galaxy, on the basis of measurements of 21-cm. radiation. The gas clouds are believed to move in practically circular orbits around the galactic center. The rotational speeds depend on the total mass of the galaxy and the manner in which that mass is distributed.

He found that the total mass of the Milky Way system is between 110 billion and 540 billion suns, depending on the assumptions made as to the size of the galaxy and the nature of its rotation. These two extreme values bracket the currently adopted figure of 340 billion suns for the mass of our neighboring spiral galaxy, Messier 31 in Andromeda.

D. W. N. Stibbs, of the Oxford University Observatory, spoke on a fundamental question in the evaluation of galactic rotation and the size of our system—the intrinsic colors of the Cepheid variable stars. Only if their true colors are known can the space reddening of these stars be evaluated, yet such evaluation must be made if we are to find the true distances of these variables by comparing their apparent and absolute magnitudes. Dr. Stibbs described four possible approaches to the problem, including one in which the reddening of each Cepheid is estimated by means of the color excesses (reddening) of blue stars in its immediate surroundings.

Two experts confer on astronomical seeing: left, Dr. John S. Hall, head of the equatorial division at the U. S. Naval Observatory, and Dr. Geoffrey Keller, who is director of the Perkins Observatory, Delaware, Ohio.

Cecilia Payne-Gaposchkin, of Harvard Observatory, made use of several hundred RR Lyrae variable stars recently discovered by Baade in the Sagittarius star-clouds. These faint and distant variables are evidently symmetrically distributed around the nucleus of the galaxy. Periods and apparent magnitudes were derived for these variable stars by Sergei Gaposchkin, also of Harvard, who used Baade's Mount Wilson and Palomar Observatories photographs. If we compare the apparent magnitudes (around 17.5 for the most part) of these stars with their absolute magnitudes, then we obtain the distance to the center, provided proper allowance for interstellar absorption can be made by the astronomer.

The important innovation in Mrs. Gaposchkin's calculation is discarding the traditional view that all RR Lyrae variables have absolute magnitudes close to 0.0. Growing observational evidence for a change comes from the fact that precise color-magnitude arrays for globular clusters cannot be exactly superimposed. Moreover, Allan Sandage, Mount Wilson and Palomar Observatories, has shown theoretically that RR Lyrae stars of younger globular clusters should be intrinsically more luminous than those in older globulars (where shorter periods prevail).

The direct determination of the absolute magnitude of RR Lyrae stars as 0.0 depended on the nearby stars of this type in the general galactic field, but these stars are no longer to be considered as identical with the RR Lyrae variables in globular clusters, nor with those at the

(Continued on page 428)

Harvard Observatory and the Smithsonian Astrophysical Observatory. Photograph by James Ufford.

Changes in the main tail and in the sunward spike are well shown in these pictures taken by Henry L. Giclas at Flagstaff, Arizona. He used the 13-inch Lawrence Lowell refractor with which the planet Pluto was discovered. Left to right, the exposures were 21, 30, and 33 minutes, respectively, on April 27th at 3:38 UT, April 28th at 3:56 UT, and May 1st at 3:54 UT. Lowell Observatory photographs.

Comments on the Sunward Tail of Comet Arend-Roland

FRED L. WHIPPLE, *Smithsonian Astrophysical and Harvard College Observatories*

THE SPECTACULAR sunward spike of the recent comet appears to require no novel theory for its explanation. The basic suggestion of Freeman D. Miller was mentioned in last month's *Sky and Telescope*, page 365; and in 1877 T. Bredichin, of Moscow Observatory, published a similar explanation he had found in 1866 for the anomalous tail of the great comet 1862 III.

The spike was simply cometary debris in the plane of the comet's orbit, seen edge on. Comet 1862 III successfully spread meteoric material along its orbital plane to produce the Perseid meteor shower that we see each August—the most reliable and conspicuous shower now observable.

Comet Arend-Roland's sunward *antitail* grew to the enormous length of 15 degrees, according to the observations of R. Fogelquist, of Uppsala, Sweden, within two or three days before April 25th, and it disappeared as rapidly. The photographs of many observers show how the antitail progressed from a broad and stubby fan to an enormous sunward ray and back again, all within a period of about a week. Jet action or electromagnetic forces to accomplish this feat would have to have been enormous.

As the antitail became longer and thinner, it turned in a clockwise fashion about the head of the comet. John Murphy, Harvard College Observatory, has assisted me by measuring some fine photographs of the comet made by Mr. Fogelquist; W. S. Butts, Pullman, Washington; C. F. Capen, Jr., and B. A. Smith, State College, New Mexico; E. Mendoza and M. Krebs, McDonald Observatory, Ft. Davis, Texas; Tore Sjögren, Hovas, Sweden; and used with their permission.

Mr. Murphy's set of measurements is plotted in the graph. They show that the cometary spike pointed directly at the sun within an hour or two of 17:00 Universal time on April 25th. From the orbit of the comet as computed by M. P. Candy, we find the striking coincidence that the earth crossed the plane of the orbit within an hour of 18:00 UT that same day. Such a coincidence could hardly be ignored, even if we did not have a simple geometrical explanation to account for it, the one given by Bredichin, Miller, and by A. B. Meinel in a personal communication. The antitail apparently consisted of rarefied material in the plane of the comet's orbit, most of it too diffuse to be easily visible far from the comet when presented to us broadside. But when the thin layer was seen edgewise, the sunlight scattered from the debris appeared to be concentrated in a conspicuous and extremely narrow spike.

Many more measures will be required to give the complete story, but the photographs themselves show that the antitail is quite a broad fan, even when seen at only moderate angles, two or three degrees above or below the orbital plane. It is evidently millions of miles in breadth, but only 10,000 miles or less in thickness, if we accept Dr. Miller's informal report that the spike became less than one minute of arc across.

Even the main tail of the comet was narrow on April 25th, compared to its broader fanlike appearance before and after the passage of the earth through the

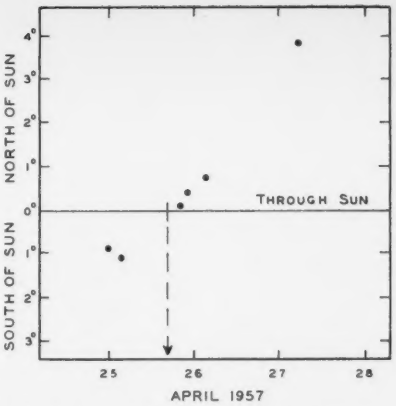
orbital plane. This suggests, in agreement with Bredichin's conclusion, that in the main tail, also, the width in the plane of the orbit is much greater than the thickness perpendicular to the orbit.

The most interesting characteristic of the antitail material is its displacement, in the orbital plane, toward the outer side of the comet's path in space. Had the material been located on the interior side of the orbit, the apparent motion of the sunward tail would have been counterclockwise. Had it been distributed symmetrically about the orbital curve, the fan would have been seen pointing almost directly at the sun both before and after its maximum extent.

This distribution of material behind the comet and to the outside of its orbit is exactly the reverse of that in the anomalous tail of Comet 1862 III as studied by Bredichin. He found that the anomalous tail was produced by matter inside the orbit of the comet and in the direction forward of the comet's motion. In fact, he deduced that the effective attraction of solar gravity on the material in the anomalous tail was 1.3 per cent greater than the normal gravitational attraction by the sun on the comet.

If we think in terms of solid material projected from the comet in all directions, these two apparently contradictory distributions can be readily reconciled. Matter shot forward toward the sun, in the neighborhood of the perihelion, will move in a smaller orbit of shorter period, with more rapid angular motion, than material which starts in a direction away from the sun. As time passes, the difference in period spreads this debris out along the orbit plane. Thus matter expelled toward the sun will stream on ahead of the comet inside its orbit, while that going away from the sun will trail behind the comet on the outside. Ejection velocities perpendicular to the orbit plane will slightly change the orbital inclination of the debris from that of the comet, but this does not add up with time to give a great spread of material away from the orbit plane.

These explanations were all clear to Bredichin some 90 years ago, but he knew



Each dot on this diagram shows the direction on the sky of the antitail, north or south of the sun, from John Murphy's measurement of a single photograph. The arrow indicates the time when the earth passed through the plane of the comet's orbit—just when the antitail pointed directly at the sun.

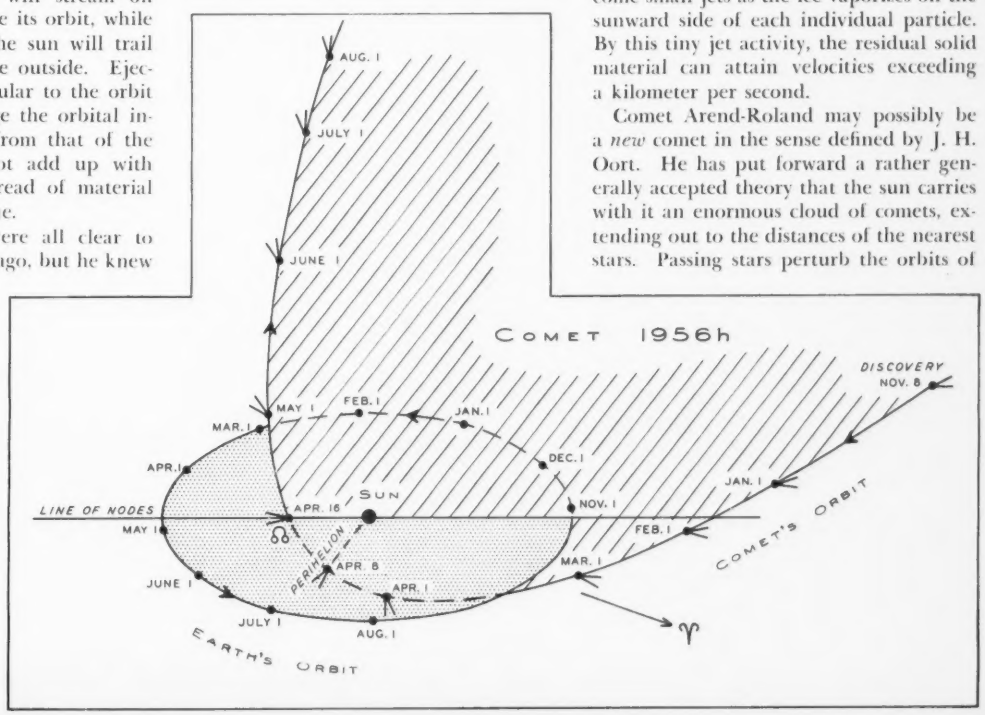
of no physical mechanism for ejecting fine dust or gas from the nucleus of a comet. Here the writer's icy model for a comet appears to provide satisfactory results. A cometary nucleus consists chiefly of ices, such as water (H_2O) and ammonia (NH_3) and possibly methane (CH_4), combined with free radicals, presumably simpler compounds of carbon, nitrogen, and oxygen with hydrogen. H. C. Urey and B. Donn, at the University of Chicago, have shown that the free radicals provide free energy, which may add to the explosive characteristics of a comet, providing more activity than my original icy-comet theory, in which only the sublimation of ices by solar heating was postulated. In a cosmic-mix source of gas we should expect a small percentage of heavier elements (silicon, iron, nickel, magnesium, and others), furnishing possible weak spongelike structures in which the ices are embedded. The existence and nature of meteors that originated from comets fortify this concept.

As such a cosmic iceberg approaches the sun, solar heat and the free radicals eject gas from the comet's surface, which carries along with it fine meteoric particles and possibly some larger ones. These will move out at velocities somewhat slower than the speeds of the gas molecules, depending upon the size of the comet, the distance from the sun, and the degree of ejection activity. Larger meteoric particles may be thrown off with velocities of 10 to 100 meters per second, and the smallest ones perhaps as fast as 300 meters per second. These numbers can now be checked by the details seen in the sunward and main tails of Comet Arend-Roland.

With this model, one may wonder how material can be ejected from the side of the comet opposite to the sun, since the solar heating will be entirely on the sunward side of the iceberg. I am not entirely satisfied with the ideas that the free radicals might produce loss of material on the comet's dark side or that there need be a time lag in ejection from all rotating cometary nuclei.

But there are other and more likely explanations for the ejection of small particles away from the sun. Light pressure and corpuscular radiation must act on the finest particles, with dimensions comparable to a wave length of light. Particles of ice that are blown out from the surface of the nucleus will, in turn, become small jets as the ice vaporizes on the sunward side of each individual particle. By this tiny jet activity, the residual solid material can attain velocities exceeding a kilometer per second.

Comet Arend-Roland may possibly be a *new* comet in the sense defined by J. H. Oort. He has put forward a rather generally accepted theory that the sun carries with it an enormous cloud of comets, extending out to the distances of the nearest stars. Passing stars perturb the orbits of



The orbit of Comet 1956h is here plotted in the plane of the paper, with the earth's orbit shown at a perspective angle of 60 degrees. Where either orbit is dashed, it is behind or below the other orbital plane. The comet reached perihelion on April 8th, and was in the plane of the earth's orbit about April 16th. On the 25th the earth passed through the comet's orbital plane.

When Comet 1956h had faded below naked-eye visibility, this picture was made with the 24-inch reflector of Yerkes Observatory, by G. Van Biesbroeck, exposure time 20 minutes, May 24th at 3:15 Universal time. The tail is a much broader fan than it was a month before, about 3½ degrees long; its left (eastern) edge is sharp and straight, while the right side is curved. Yerkes Observatory photo.

these comets to bring some of them in close to the sun, so they are removed momentarily from the icebox of interstellar space. A new comet is one that comes close to the sun for the first time in its history. The solid material on the surface of such comets is probably extremely feathery, and there is very little lag in the penetration of solar heat and the subsequent ejection of material.

Thus we see that light pressure, corpuscular radiation from the sun, and the jet action of small ice particles probably are adequate to explain the stream of dust that trailed behind Comet Arend-Roland and produced the spike. The forward ejection of material from the icy nucleus can probably also account for the material seen inside the orbit of Comet 1862 III. In this latter case, the resistance by the solar corona (following a recent suggestion by E. Opik) may have caused the material to move in smaller orbits around the sun.

Comet Arend-Roland provides a great opportunity for detailed studies of the ejection of material from comets, the formation of meteoric streams, and the general contribution of material to the zodiacal cloud. From extensive and detailed spectral observations, we can hope to learn a great deal. For instance, if the sunward tail of this comet showed an appreciable gaseous spectrum, then we must conclude that such gases had been occluded among the solids that had come from the nucleus and had produced the general diffuse scattering. If so, here is another means of gaining information about the chemical and physical nature of a cometary nucleus.

COMET 1956h EPHEMERIS

The following position predictions (1950 co-ordinates) and estimated magnitudes of Comet Arend-Roland are from computations by Dr. Z. Bochnicek, Skalnate Pleso Observatory. They are for 0^h Universal time: **July 1,** $9^h\ 13^m.7$, $+59°\ 58'$, 9.1; **11,** $9^h\ 34^m.4$, $+59°\ 13'$, 9.7; **21,** $9^h\ 53^m.6$, $+58°\ 39'$, 10.1; **31,** $10^h\ 11^m.8$, $+58°\ 14'$, 10.5. **August 10,** $10^h\ 29^m.4$, $+58°\ 00'$, 10.9.

However, the comet may be about 1.0 magnitude fainter than predicted above; this is suggested by magnitude observations of 6.9 on May 24th, 3:15 UT, by G. Van Biesbroeck, and 8.0 on May 29th, 4:00 UT, by L. Jacchia.

AMERICAN ASTRONOMERS REPORT

(Continued from page 425)

galactic center. The last group has an exaggerated preference for the very short periods (around 0.3 day instead of half a day) exhibited by variables in old globular clusters. Therefore, Mrs. Gaposchkin has adopted +0.76 for the absolute magnitude of the galactic center variables.

On this basis, the distance of the nucleus may be as great as 11,200 parsecs (36,500 light-years). This value is an upper limit, for space between us and the center of the Milky Way could be somewhat less transparent than implied by Mrs. Gaposchkin's adoption of 1.5 magnitudes for the effect of interstellar absorption.

It was with just this problem, space reddening and absorption, that the sixth speaker at the conference, A. E. Whitford, Washburn Observatory, was concerned. He pointed out that Baade's final value for the center's distance depended on measures made in 1946 of the reddening of the globular cluster NGC 6522, which lies in the center of Baade's original field of variable stars, and at a distance slightly greater than that of the variables themselves.

Dr. Whitford has re-examined the 1946 measures of NGC 6522 in view of our present knowledge of the law of space reddening and of the characteristics of globular clusters. The total photographic absorption of 2.7 to 2.9 magnitudes adopted by Baade is probably too high. Dr. Whitford said, "It would not be surprising if the photographic absorption in front of the bulge variables is as low as 1.5 magnitudes." (This is the same figure Mrs. Gaposchkin used.) The consequence would be a large upward revision in Baade's 8,200-parsec distance to the center.

The general consensus of conference opinion appeared to be that our Milky Way system is larger than had been supposed, by perhaps 25 per cent; it was agreed, however, that the difficult problem of establishing its size precisely requires much further study.

Does the Cassiopeia-Taurus Group Exist?

Many years ago Kapteyn noted that a widely scattered group of bright *B* stars, from Taurus to Cassiopeia, were moving together in space. In 1954 A. Blaauw confirmed this community of motion, and argued for a common origin of these stars some 70 million years ago.

At the Dominion Astrophysical Observatory, R. M. Petrie has measured the radial velocities of 40 *B* stars attributed to the group, from about 670 spectrograms taken with the 73-inch telescope at Victoria. Dr. Petrie found the apparent stream motion seems to be merely a combination of solar motion and small random stellar motions. He is therefore inclined to the interpretation that these Cassiopeia-Taurus stars do not form a moving group.

The Constancy of the Solar "Constant"

The amount of solar radiation reaching the earth—about 1.946 calories per square centimeter each minute, after atmospheric absorption is allowed for—has long been suspected of variations. But Theodore E. Sterne and Nannielou Dieter, of the Smithsonian Astrophysical Observatory, now deny the occurrence of appreciable changes. They have compared solar radiation measurements made simultaneously at Montezuma, Chile, and Table Mountain, California, between 1926 and 1955. So well do the measures at these two Smithsonian stations agree that it may be concluded that the solar constant, if it varied at all, underwent fluctuations averaging less than 0.17 per cent.

Could a meteorite's impact have made the large circular crater in this picture of a desolate region in central Australia? Five pits lying in the salty claypan at the right could perhaps have been caused by fragments from a central explosion. This is a portion of an official Royal Australian Air Force photograph, taken in 1950 from an altitude of 25,000 feet and reproduced by special permission. The tiny dots are vegetation; the scale is about 4,100 feet per inch.

Another Meteorite Crater in Australia?

RALPH L. SANGSTER, *Astronomical Society of South Australia*

A LARGE CRATER, possibly of meteoritic origin, has been discovered in central Australia on pictures made during a Royal Australian Air Force aerial survey in 1950. If it is indeed meteoritic, it will rank as one of the largest such craters in the world.

As the aerial photograph shows, the formation lies in a salt-encrusted claypan, in which the crater's outer rim has formed an "island" about two miles in diameter. Near its center is the inner crater, about 50 feet deep and 2,000 feet across, its level circular bottom estimated to be 700 feet in diameter.

The practically inaccessible site is about 80 miles from Mt. Doreen, northwest of Alice Springs, Northern Territory. It was reached by surface travel last year by the first white man to visit the crater, Dr. P. S. Hossfeld, senior lecturer in geology at the University of Adelaide, who had made several previous unsuccessful attempts. Another expedition is planned by him for about August, to examine the formation more critically.

Dr. Hossfeld and a native driver needed four days in a four-wheel-drive truck to negotiate the final 80 miles of sand hills and claypans strewn with thorny spinifex. The driver refused to cross the crater on foot, fearing the location was connected with a legendary "fiery snake." Shortage of fuel, water, and food necessitated an almost immediate return.

The Australian scientist believes there is no geological evidence for a terrestrial origin of this crater and that meteoritic impact is therefore suggested. No fragments of meteorites were found by him on the surface of the loose sand, but this does not invalidate the possibility of such an explanation. The claypan was in a boggy condition when Dr. Hossfeld walked across it. Smaller craters and pits in the vicinity of the main crater could possibly indicate the impacts of several meteoritic masses.

The dry, sandy nature of the country makes it subject to rapid change. Water-made runnels are seen making a noticeable fringe around the edge of the crater; as these would be altered quickly, their presence may indicate comparatively recent formation, perhaps 100 years ago.

Two other craters, of known meteoritic origin, are located in the Northern Territory of Australia, at Henbury and Boxhole Station, which are also in the general vicinity of Alice Springs.

Amateur Astronomers

Northeast Convention Is Held at New Haven

SOME 150 amateurs, representing 14 societies of the Northeast Region, attended its convention at State Teachers College, New Haven, Conn., on April 27th. It was one of the largest regional conventions of the Astronomical League ever held.

Among the morning session speakers was D. S. Kimball, Yale University Observatory, who talked on visual observing of the aurora, the subject of his article (with C. W. Gartlein) in the May issue of *Sky and Telescope*. Charles Downton described the activities of the junior group at Springfield, Mass., while John Welch told how the adult amateurs in that same city, the Springfield Stars, had made the mirrors and mountings for 15 telescopes.

Following the group photograph and lunch, R. B. Bourne, of West Hartford, Conn., related his adventures in astronomical photography. He stressed a rugged camera mounting and careful guiding as the keys to success, and showed a picture of Comet Arend-Roland. Philip D. Stern, of Stratford, Conn., described the simple devices he uses to teach astronomy in the Boothe Memorial Astronomical Society. Robert E. Cox, Cambridge, Mass., discussed the making of Cassegrainian-Maksutov lenses.

The MOONWATCH program had its share of attention, as William Knight, of the Amateur Telescope Makers of Boston, gave directions for assembling a satellite observing telescope; Ralph Dakin, Rochester, N. Y., described the inexpensive telescopes made by his club's members; and Jack Slowey, Smithsonian Astrophysical Observatory, reviewed recent developments in the over-all satellite-tracking program.

At the convention dinner, Dr. Dirk Brouwer, director of Yale University Observatory, traced the public and government support of science from the early colonial days to the present. The banquet ended dramatically as Dr. Armand Spitz announced that the first trial MOONWATCH flyby was in progress at that very moment over the Washington, D. C., area.

The following regional officers were elected: Mr. Dakin, chairman; Albert Farian, Bridgeport, Conn., vice-chairman; Mrs. Shirley Tuckman, Springfield, Mass., secretary; and Mr. Welch, treasurer. The region's 1958 meeting will be held in conjunction with the general convention of the league at Cornell University.

MRS. HELEN VELARDI
108 Orange St.
New Haven, Conn.

Mrs. Margaret W. Mayall, director of the American Association of Variable Star Observers, speaks at the recent convention of the Northeast Region of the Astronomical League. To her left are Dr. Armand Spitz, of Spitz Laboratories, and Dr. Dorrit Hoffleit, director of Maria Mitchell Observatory. To Mrs. Mayall's right are Dr. Dirk Brouwer, director of Yale University Observatory, Miss Grace C. Scholz, president of the league, Dr. Harlan Smith, Yale University Observatory, and Mrs. Helen Velardi, of the New Haven Astronomical Society, the meeting's host group.

Western Amateur Astronomers to Meet in Berkeley

THE NINTH annual convention of the Western Amateur Astronomers will be held in Berkeley, California, from Friday through Sunday, August 16-18. The sponsor is the Eastbay Astronomical Society, of Oakland, with the University of California as host. Most of the sessions are scheduled at Leuschner Observatory, on the campus of the university.

Besides talks by many amateurs, there will be papers by professional astronomers. At the annual dinner on Friday evening at the Claremont Hotel, the G. Bruce Blair medal will be presented to Mrs. Margaret Mayall, director of the American Association of Variable Star Observers.

There will be a field trip to Lick Observatory on Mt. Hamilton Saturday evening, with a tour of the 120-inch telescope, second largest in the world. Throughout the three-day meeting, the Eastbay group's Chabot Observatory and MOONWATCH station will be open for inspection.

The registration fee of $2.25 may be sent in advance to Mrs. Fanny Bulger, 436 Lester Ave., Oakland, Calif. Steve Burke, 8676 MacDonald Way, Hayward, Calif., is in charge of displays. Program time and other information may be secured from the convention chairman, Walter C. Marion, 3516 Lyon Ave., Oakland, Calif.

OHIO TURNPIKE AMATEURS

On May 4th, 107 members of the Ohio Turnpike Amateur Astronomers (see *Sky and Telescope*, April, 1956, page 263) met at Baldwin-Wallace College, Berea, Ohio, with Dr. Paul Annear as host and main speaker. Seven societies were represented: Astronomy Club of Akron, Junior Astronomers of Bay Village, Black River Astronomical Society of Elyria, Cleveland Astronomical Society, Toledo Astronomical Society, Mahoning Valley Astronomical Society of Warren, and Youngstown Astronomy Club.

At an informal meeting, on April 9th, of representatives from Akron, Elyria, and Toledo, the group scheduled future conferences for July at Akron, August at Warren, and September at Toledo. It was also decided to publish a directory of all members in the seven societies, as well as a circular to list items of equipment available for exchange.

NANTUCKET OPEN NIGHTS

Summer visitors to the island of Nantucket, Massachusetts, are invited to a series of Monday night lectures at Maria Mitchell Observatory by Dr. Dorrit Hoffleit, the new director. The weekly sessions will be held until September 9th.

The lectures will begin at 8:00 p.m., and later the observatory's telescopes will be available for observing. There will be a nominal admission charge.

Further News About the Kansas City Convention

REGISTRATION is now open for the general convention of the Astronomical League, to be held at the University of Kansas City, August 31-September 2. Until July 31st, the registration fee will be $1.00 per person; from August 1st, it will be $2.00 per person or $3.50 per family.

Remittances for registration should be mailed to Mrs. Helen Edwards, Registration Chairman, 7217 Madison, Kansas City, Mo. Room reservations for the university's air-conditioned dormitory at $2.50 a night per person may also be made with Mrs. Edwards.

In addition to the league convention, the Association of Lunar and Planetary Observers, which will be celebrating its 10th anniversary, and the Mid-States Region of the Astronomical League will hold their annual meetings on Monday, September 2nd.

The accompanying tentative schedule of the convention includes the titles of papers that were placed on the program up to May 20th.

Friday, August 30

All day	Setting up of exhibits.
2:30 to 5:00 p.m.	Council meeting.
3:00 to 7:00 p.m.	Registration.
7:00 to 10:00 p.m.	Informal get-together.
9:00 to 11:00 p.m.	Council meeting.

Saturday, August 31

9:00 to 10:30 a.m.	Registration.
10:30 a.m. to noon	*Opening Convention Session.* Welcome by Fred Hartman, president of the Kansas City Astronomy Club. Roll call of societies. Reports by officers, nominating committee, and section chairmen.
1:30 to 4:00 p.m.	*Earth Satellite and MOONWATCH Session.* Chairman: Dr. Armand Spitz, Smithsonian Astrophysical Observatory. Papers: Dr. J. Allen Hynek, "The Earth Satellite Program as of August 31, 1957." Steadman Thompson, "Who Knows What About the Russian Satellites?" Col. Owen F. Clarke, USAF, "How It Feels To Be a Simulated Satellite—and Flyby Problems." Dr. Spitz, "Problems of MOONWATCH Operations and Practice Sessions."
4:15 to 5:30 p.m.	Talk by Dr. Joseph Shipman, director, Linda Hall Library, "Rare Astronomical and Related Science Books," to be followed by tour of the library.
7:30 to 11:00 p.m.	*Star Party and Observing Techniques Session.* Chairman: Russell C. Maag, Sedalia, Mo. Instructors: Walter H. Haas and Dale P. Cruikshank, moon and planets; Robert M. Adams and E. D. Tarbell, variable stars; Edwin Friton, meteors; Mrs. Helen Warkoczewski and Stuart O'Byrne, constellations and star colors.

Sunday, September 1

10:30 a.m. to noon	*Meteoritic Astronomy.* Chairman: Edwin Friton, St. Louis, Mo.
1:00 to 1:30 p.m.	Group photograph.
1:30 to 3:00 p.m.	*Junior Session.* Chairman: Clarence E. Johnson, Schenectady, N. Y.
3:30 to 4:30 p.m.	*Business Meeting.* Election of officers.
4:30 to 5:00 p.m.	Talk by Dr. William C. Doyle, S. J., Rockhurst College, "Mathematics and Astronomy."
6:30 p.m.	*Convention Banquet.* Toastmaster: Dr. Floyd F. Helton, director, Morrison Observatory, Central College. Guest speaker: Dr. Richard N. Thomas, National Bureau of Standards, "Some Current Problems of the Solar Chromosphere." Presentation of Astronomical League award.
9:30 to 11:00 p.m.	*Star Party.* Council meeting.

Monday, September 2

8:30 to 9:30 a.m.	Meeting of the Mid-States Region.
9:30 to 10:30 a.m.	*Panel of Experts.* Moderator: Charles A. Federer, Jr., Harvard Observatory.
10:30 to 11:00 a.m.	*Final Session.*
11:00 a.m. to noon	Meeting of the Association of Lunar and Planetary Observers.
1:30 to 5:00 p.m.	*ALPO Session.* Chairman: Walter H. Haas, Las Cruces, N. M. Papers: Mr. Haas, "The First 10 Years of the ALPO." Robert M. Adams, "The Enigma of Meteoritic Impact Flares on the Moon." Frank R. Vaughn, "The Canals of Mars: From Schiaparelli to 1956." Alika K. Herring, "Some Recent Observations of Plato."

CONTEST TO RENAME LEAGUE "BULLETIN"

To find a more descriptive name for its *Bulletin*, the Astronomical League is running a contest that is open, through July 31st, to all members of societies belonging to the league. A statement in 25 words or less should explain the reason for each proposed name, and should be accompanied by the contestant's name, address, and club affiliation. Contest entries may be sent to the *Bulletin* editor, Mrs. Jane Gann, 420 N. Cassady Rd., Columbus 9, Ohio. The winning name will be announced at the Kansas City convention at the beginning of September.

NORTH CENTRAL CONVENTION

With the St. Paul Telescope Club acting as host, the 11th annual convention of the North Central Region of the Astronomical League was held on May 11th at Macalester College, St. Paul, Minn., with 66 participants, representing 11 societies in four states.

The morning session was devoted to a talk by Carl H. Gamble, Moline, Ill., on his many years as an amateur astronomer. After luncheon, Dr. S. R. B. Cooke, professor of metallurgy in the school of mines, University of Minnesota, gave an address on amateur Schmidt photography, showing slides of unusual lunar photographs and giving a detailed description on the operation of a Schmidt camera. Edward A. Halbach, of the Milwaukee Astronomical Society, told about the earth satellite program.

Following a tea given by the college, Dr. C. M. Huffer, of Washburn Observatory, discussed the literature of astronomical observations and findings. At the business meeting, new officers were elected: H. B. Porterfield, Madison, Wisc., chairman; Richard R. Finck, Milwaukee, Wisc., vice-chairman; and the undersigned, secretary-treasurer.

At the convention banquet, Dr. W. J. Luyten, chairman of the department of astronomy, University of Minnesota, spoke on radio astronomy. The balance of the evening was spent visiting the Wilke Observatory on the Macalester College campus, where several telescopes were displayed.

MRS. W. A. HOOPER
1719 Bayard
St. Paul 16, Minn.

NEWS NOTES

HUGE SOLAR FURNACE

At a site near Cloudcroft, New Mexico, not far from Sacramento Peak Observatory, the U. S. Air Force will construct a mammoth solar furnace capable of producing temperatures as high as 8,000° Fahrenheit. The installation will be operated by scientists from nearby Holloman Air Development Center, where astronomer Paul D. Jose has developed design theory and conducted performance studies for the furnace.

The general arrangement of the new furnace will resemble that of the U. S. Army's installation at Natick, Massachusetts, illustrated on page 332 of the May issue. The heliostat in the Natick design measures 40 by 36 feet, whereas the Air Force heliostat will be 140 feet wide and 130 feet high, and its paraboloidal focuser will be of like dimensions. The device concentrates the energy of solar radiation 25,000-fold.

Operation of the new furnace is expected to begin early in 1959, its chief purpose being to investigate the effects of rapid temperature changes on the metals used in rocket and missile construction. Research will be carried on by the Department of Defense, the Atomic Energy Commission, the National Advisory Committee for Aeronautics, and some industries engaged in national defense work.

UNIVERSITY OF ROCHESTER EXPANDS ASTRONOMY PROGRAM

The physics department at the University of Rochester, in upper New York State, will be broadened on September 1st to include both physics and astronomy. Dr. Robert E. Marshak is to be chairman of the new department, which will offer a B. S. degree in astrophysics and a Ph.D. degree in physics and astronomy. The new program will also involve the university's Institute of Optics.

SUPERNOVA IN M84

A widely observed supernova has appeared about 1½ minutes of arc north of the elliptical galaxy Messier 84 (NGC 4374) in Virgo. The first reported discovery was by G. Romano in Italy, who recorded the new object as a 13th-magnitude star on May 18th.

According to a later announcement, this supernova was independently discovered by H. S. Gates, Mount Wilson and Palomar Observatories, on a film taken with the Palomar 18-inch Schmidt camera on April 24th. The photographic magnitude then was 13.4. The star was also found by E. F. Carpenter, Steward Observatory, on a plate of May 3rd.

The near agreement between the magnitudes on April 24th and May 18th suggests that the supernova reached maximum brightness between these dates, and is now fading. The position for 1950 of M84 is $12^h\ 22^m.6$, $+13°\ 10'$; it is of magnitude 10 and about three minutes of arc in diameter.

BRITISH SYMPOSIUM ON HIGH-ALTITUDE ROCKETS

A symposium on high-altitude and satellite rockets will be held at the College of Aeronautics, Bletchley, Buckinghamshire, England, from July 18th to July 20th. The college, the Royal Aeronautical Society, and the British Interplanetary Society are sponsoring the meeting, which will discuss nonmilitary applications and future developments of rockets.

This clock is believed to have been built by Sir William Herschel in 1806. The great British astronomer was a talented instrument maker. Besides constructing for his own researches the largest reflecting telescopes in the world, he made scores of others for sale. With his own hands he turned out eyepieces, micrometers, and other accessories he used on his telescopes. American Museum-Hayden Planetarium photograph.

IN THE CURRENT JOURNALS

THE TRANSITS OF MERCURY, 1920 TO 2080, by J. Meeus, *Journal* of the British Astronomical Association, December, 1956. "In a century there are thirteen or fourteen transits of Mercury. Between the years 1600 and 2500 there are 122 transits, of which eighty-two occur in November and forty in May. The number of November transits is thus twice that of the May transits."

THE EARTH'S CHANGING CLIMATES, by Erling Dorf, *Weatherwise*, April, 1957. "Geologically speaking, there is no doubt that the world's climates are changing; moreover, geologic evidence indicates that climates have been changing—first in one direction, then in another—for many millions of years."

V.H.F. METEOR SCATTER PROPAGATION, by Walter F. Bain, *QST*, April, 1957. "Since 1953, when W4AO and W4HHK first observed meteor-scattered signals on 144 Mc. while attempting a tropospheric contact, this medium of communication has been of increasing interest to serious v.h.f. amateurs. And well it might be, for it provides a means of making 2-meter contacts over distances of 500 to 1500 miles. Meteor scatter is no mode for the casual operator, however, for it requires some power, large antennas, sensitive receivers, and no small amount of patience and operating skill at both ends of the path."

THE LOST PLANET, by N. J. Berrill, *Atlantic*, June, 1957. "The likelihood that meteorites are fragments of one or more planets has opened up the exciting opportunity to find out just how planets are made, quite apart from curiosity concerning what happened to break one into small pieces."

LARGE CLOCK BY HERSCHEL IS ON EXHIBIT

One hundred and fifty years ago, the famous astronomical observer, Sir William Herschel, built a clock 12 feet tall for timing observations at Slough, England, with his reflecting telescopes of up to 48 inches in aperture. The historic timepiece is now being exhibited at the American Museum-Hayden Planetarium in New York City, on loan from Fordham University.

The clock is four feet wide at its base, and its massive works are visible through the center of the clock face. The movement has recently been adjusted with the co-operation of the Longines-Wittnauer Watch Co.

Little is known of the clock's early history, and how it reached the United States is uncertain. It was acquired by Fordham University from Woodstock College, Maryland, in the 1890's.

INTERNATIONAL GEOPHYSICAL YEAR BEGINS

(Continued from page 411)

The United States program in meteorology is designed primarily to study the atmosphere's structure and motions. There will be reports from strategic new observing stations in the Southern Hemisphere, operated mostly in co-operation with other nations. A cross section of the atmosphere from pole to pole will be studied along the region of 70°-80° west longitude. Antarctic weather observations will be extensive.

Work on the aurora, especially visual studies, and the Canadian visual program of meteor observing were described in the May issue of *Sky and Telescope* (pages 317 and 327).

As a part of the ionospheric physics program, fluctuations in the energy of discrete radio sources (radio "stars") will be measured by three astronomical radio receivers in a closely spaced network at Charlottesville, Virginia. These radio-star scintillations are related to the drift motions of irregularities caused by air movements (winds) in the very high electrified layers of the atmosphere. Radio-star scintillation varies rapidly in the auroral zone, and it seems highly possible that marked changes occurring within a few minutes may result from the transit of an aurora or sporadic-E cloud across the line of sight.

Observations of the sun will be intensified during the IGY, with American solar observatories keeping daily records of sunspots, calcium plages, coronal emission, sunspot magnetic fields, and prominence activity. It is expected that flare patrols will be maintained at the Naval Research Laboratory, McMath-Hulbert Observatory, the High Altitude Observatory at Climax, Colorado, at Sacramento Peak Observatory in New Mexico, and at the University of Hawaii. Very complete coverage is anticipated since each continental longitude belt is covered by two observatories with equivalent programs and equipment, and Hawaii is noted for its good weather record.

At Mount Wilson Observatory, spectroheliograph observations will be continued, and the U. S. Naval Observatory will use a hydrogen-alpha filter for flare observations. There will be indirect flare detectors at several places—these monitors of sudden ionospheric disturbances serve to alert us to flare-type events on the sun. Rensselaer Polytechnic Institute will operate a sudden cosmic noise absorption recorder of its own design.

Continuous radio observations of the sun have been proposed for Ann Arbor, Michigan; Boulder, Colorado; Ft. Davis, Texas; College, Alaska; Ithaca, New York; Makapuu Point, Hawaii; Sacramento Peak, New Mexico; Washington, D. C.; and elsewhere. The IGY rocket program includes various solar studies from high-altitude sounding rockets.

The final results of studies of the sun during the IGY will provide detailed astrophysical data on many of the solar events that may be associated with the terrestrial phenomena studied by purely geophysical means. In fact, the solar-terrestrial problem is at the core of the entire IGY program, to the extent that the period of the IGY was chosen to coincide with the expected maximum of solar activity.

A wide variety of cosmic ray experiments will be undertaken at stations all over the globe. In order to study the primary cosmic ray spectrum, a series of nearly simultaneous balloon and rocket flights will be made at various latitudes, both on quiet days and magnetically disturbed days. The flights will carry aloft Cerenkov counters, proportional counters, pulsed ionization chambers, Geiger counters, and photographic emulsions. The energy spectrum of cosmic rays is known to extend from about 500 million electron volts to possibly 10^{19} electron volts or more. There exist between fluctuations in cosmic ray intensity and solar phenomena important correlations, which are to be checked during the IGY.

The United States will participate in the longitudes and latitudes program at three observatories, in Washington, D. C., San Diego, California, and the Hawaiian Islands. It will supply Markowitz dual-rate moon position cameras (*Sky and Telescope*, November, 1953, page 5) suitable for attachment to long-focus telescopes at about 20 astronomical observatories located in various parts of the world, and will undertake to measure approximately one fourth of the photographic plates taken by the 20 cameras. Three measuring engines of special design are being provided to other observatories making the remaining measures. The U. S. Naval Observatory has been made the central agency for the moon-position program.

As it permits observation of the moon's position with respect to the stars to a higher precision than by any other method, the Markowitz camera technique should aid in such problems as uniform time, the earth's size, shape, and irregular rotation. For the lunar method, however, the distance to the moon must be accurately determined by direct triangulation—a baseline from Washington to San Diego has already been measured.

The information presented here has been taken from the booklet, *Proposed United States Program for the International Geophysical Year 1957-58*, published last year by the National Academy of Sciences-National Research Council, Washington, D. C. Details of some of the programs may have been changed, but not their basic purposes or methods of observation.

An impressive section of the booklet is the list of rocket firings scheduled for the IGY, demonstrating the importance of rocket research vehicles to modern scientific investigations. There will be 45 Aerobee rockets fired, 52 Nike-Cajun combinations, 50 Nike-Deacons, and 60 Rockoons (*Sky and Telescope*, March, 1957, page 223). At Ft. Churchill, Canada, 75 rockets will be launched, while other firings are scheduled for White Sands Proving Ground; Point Magu, California; Guam; Holloman Air Force Base; also from ships in the arctic, antarctic, and at the equator. H. M. C.

CORRECTION

On page 321 of the May issue, in the fourth line from the bottom of the third column, for one per cent read 10 per cent.

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BULLETIN FOR Visual Observers of Satellites

NUMBER 7 | 60 GARDEN STREET, CAMBRIDGE 38, MASS. | JULY, 1957

First Nationwide Test Alert Is Successful

Seventy-five MOONWATCH teams in the United States took part in the first nationwide test alert, during the evening of Friday, May 17th. This trial indicated that at least half of these stations have already reached a state of readiness to observe the artificial earth satellite when it is launched into its orbit. Of those stations not yet prepared for actual satellite observing, many are showing progress that should bring them to the desired status within a few weeks.

The turnout of MOONWATCH observers was gratifying, with more than 1,200 of the members of the 75 stations reporting for observing—a 70-per-cent response. In report after report to headquarters on the evening of the alert, leaders emphasized the enthusiasm among their team members, stating that the test had served greatly to increase interest in the visual observing program.

This was true in spite of the weather, which was unfavorable in almost every section of the country. Clouds covered most of the stations; there were downpours, floods, and tornado warnings. Fewer than 20 stations observed under starry skies, and in some instances the weather was intermittently cloudy.

Under those circumstances, there were few observations to report, and in all cases the objects seen were airplane navigating lights or meteors. Six flights by aircraft to simulate satellites had been scheduled in widely separated parts of the country. The results of the flyby observations cannot be evaluated at this time, since flight data are unavailable as this bulletin goes to press.

In future alerts it is expected that more flights will be scheduled. To imitate the conditions of actual satellite observation, these flybys will be unannounced. Already being tested is a new device, to be towed by a plane, which will have an apparent brightness comparable to the satellite at perigee.

At MOONWATCH headquarters in Cambridge, Massachusetts, on the night of the May alert, five telephones were manned by Smithsonian Observatory staff members to receive the report of each station. The nation was divided into five strips, running east and west, the stations in each latitude belt reporting to one telephone. Each station leader's message, as soon as it came in, was carried in written form to the operations room. As evening twilight progressed across the country, more and more westerly teams were heard from, the last report, from Portland, Oregon, being received in Cambridge at 1:33 a.m. EST. The alert was a test of headquarters operations as well as of field stations.

MOONWATCH in Japan

Even though the Japanese MOONWATCH program got under way as recently as last fall, 25 stations are already registered with the Smithsonian Observatory, and more are expected.

Upon my appointment as coordinator of satellite

Left: At MOONWATCH headquarters in Cambridge, on the night of the test alert, Dr. J. A. Hynek receives a telephone report as A. B. Ledwith records; watching at the extreme right is Dr. M. Miyadi, coordinator of Japanese satellite observers.

Right: Dr. Armand Spitz marks Edinburg, Texas, on the map where black dots show stations already reported. With him, left to right, are Drs. F. L. Whipple, Miyadi, and Hynek. Sky and Telescope *photographs by Robert E. Cox.*

The coordinator for the visual satellite observing program in Japan, Dr. Masasi Miyadi, is the director of Tokyo Astronomical Observatory. Here he stands by a working model of the satellite's orbit, at MOONWATCH headquarters, where he has been studying satellite-tracking techniques. Sky and Telescope *photograph by Betty Merrylees.*

tracking by the Japan IGY Committee, I enlisted the aid of the Astronomical Society of Japan, the Oriental Astronomical Association, the Japan Astronomical Study Association, and the Ikomasan Astronomical Society. In addition, the Japanese Astronautical Association may participate.

The stations are fairly well distributed among the main islands of Japan, although somewhat more densely in the lower latitudes. They range from 32° to 44° north.

Our teams are comprised mainly of college and high school students, averaging about 20 members in each. The leaders are generally experienced amateur and semiprofessional astronomers. Three Japanese newspaper syndicates, Mainichi Press, Osaka Yomiuri Press, and Tokyo Yomiuri Press, have agreed to sponsor the Japanese MOONWATCH effort, covering the cost of equipment for most of the stations.

MASASI MIYADI

XIII. Lessons Gleaned from the May Alert

A. Position and Time. In a number of instances stations did not report clearly the position and time of a sighted object. The meridional altitude frequently was given without stating that the object was above the north or south point of the horizon. The angle should be measured to the nearest degree and reported, for example, as 49° N, denoting an object 49° above the north point of the horizon.

Likewise, the times given for meridian passages of the objects were sometimes ambiguous because it was not stated what zone time was used. The times should be given in *Eastern standard time,* and should be designated as such in both the telephoned and written reports. In addition, the times should be denoted as *a.m.* or *p.m.* Since most of the observing stations will be tuned in to WWV time signals, which are given in Eastern standard time, by this system there is little possibility that errors will be made in reporting time.

Some stations were unfamiliar with the procedures of WWV, and were unprepared for timing during the intervals when it was off the air. As explained by M. Francis in *Sky and Telescope* for October, 1956, page 545, WWV signals are off the air once an hour for a period slightly longer than four minutes, the interval beginning approximately 45 minutes after the hour. A stop watch may be used to measure time during this interval, or a metronome provided to record the seconds beats into the tape recorder.

B. Star Charts. The alert pointed out the need for preparation of reversed star charts to show each observer the stars as they appear in his telescope. A reversed chart may easily be made by copying the appropriate portion of the Skalnate Pleso atlas on tracing paper, the reverse side then presenting the field of stars as they will be seen. Another method is blueprinting, with the master chart reversed onto the blueprint paper. Ordinary photography and other methods of reproduction in which reversal is possible also may be employed. The Skalnate Pleso charts that have been supplied to registered teams should be carefully preserved.

C. Observing Strain. It becomes increasingly clear that observers undergo eye fatigue and lose efficiency after gazing into the eyepiece continuously for longer than 10 or 15 minutes. Statements to this effect were made by a number of team leaders. To avoid this difficulty, some stations had conducted tests before the alert and set up relief schedules for observers. Suggestions for coping with the fatigue problem are desired, and effective methods will be disseminated to team leaders.

D. Notification. Many stations requested that future alerts be announced farther in advance, even as long as 10 days. They stated members often had made "important prior commitments." While short advance notice can present difficulties for individual observers, it is, nonetheless, necessary to simulate conditions that will exist when the satellite is aloft. When a launching is imminent, MOONWATCH teams will probably be called with little warning—possibly only a few hours. Thus, test alerts called on short notice provide a basis for evaluating the ability of stations to get into action.

However, certain shortcomings in the notification system used in the first test alert are evident. Because of delays in the mail, several team leaders did not receive the special bulletin as early as expected, and thus were unable to plan adequately for the session. Hereafter, the special bulletin will be mailed in time to reach leaders about two weeks before a scheduled alert. It will contain all the instructions for the alert except the date and twilight period, which will be telegraphed to arrive at least 48 hours beforehand.

E. Communications. The effectiveness of telephone communication between stations and MOONWATCH headquarters was demonstrated satisfactorily. Sixty-seven of the 75 calls during the alert were received within five minutes from the time they

were placed; six more were received within 10 minutes; only two were delayed for more than 15 minutes. The eight calls from California to Cambridge required an average interval of three minutes. Experience on this occasion proved that the telephone is fully adequate for test alerts and for the eventual reporting of actual observations.

F. Written Reports. Written reports to MOONWATCH headquarters were sometimes delayed, and about a dozen of them had not been received more than one week after the test alert. Delays were generally due to failure in mailing reports immediately after the alert, and to failure in sending them by airmail. The written reports serve a vital purpose at MOONWATCH headquarters, where they are the basis for evaluating progress and observational techniques.

G. State of Readiness. The readiness of the MOONWATCH stations was very gratifying. Much of the progress was accomplished, apparently, during the month before the alert. The reports showed that fully 50 per cent of the registered teams are now completely instrumented, and generally prepared to observe the satellite. Stations not ready for actual observing have been inspired by the test to speed their efforts, several team leaders reported.

A Setup for Table-top Observing

Illustrated below is an arrangement of observers to show the simple setup of a station using the method of table-top observing described by Dr. George Van Biesbroeck in *Bulletin* No. 5 (February, 1957). The 12 observers are seated in pairs around three of the tables, while the leader sits with the tape recorder and the short-wave receiver for the time signals.

The fields of the telescopes are completely free of obstruction; there are no reticles. Each telescope is mounted so that for nearly all altitudes the eyepiece remains the same height above the table. The instruments are aligned in a nearly north-south line by resting their bases against parallel straightedges clamped on the tables. These cleats are oriented with a magnetic compass or by sighting the Pole Star. With the star-map technique, good observations of satellite positions are possible without pointing each telescope more accurately than within a degree or so.

Proper elevation of each telescope is set with a mechanic's protractor level, as shown in the diagram. Two observers on the same side of each table watch adjoining sky areas so they can use the same map between them. Or, cutout overlays can be provided, through which the observer sees on his chart only the part corresponding to his telescopic field of view. When a moving object is seen, the observer signals the time of its passage near a star, or when it is halfway between two stars, or when it forms a special configuration in the field. This timed position is immediately plotted, and the right ascension and declination of the object can be measured directly from the chart.

Technical Editor Appointed

Jack W. Slowey, physicist on the staff of the Smithsonian Astrophysical Observatory, has assumed additional duties as technical editor of the *Bulletin for Visual Observers of Satellites.* He continues his work in the computations section, in connection with planning calculations of the satellite's orbit from observations by MOONWATCH teams. Mr. Slowey joined the Smithsonian staff in September, 1956, after receiving his master's degree in astronomy at the Washburn Observatory of the University of Wisconsin.

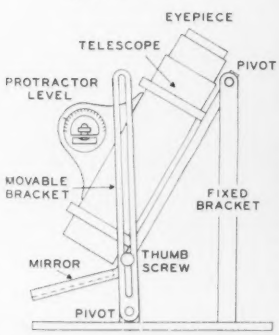
JACK W. SLOWEY

Correction to Bulletin No. 6

Many readers have called attention to the fact that the caption of the picture in the upper left on page 2 of the May *Bulletin* should have referred to a mountaintop in Santiago, Chile, instead of in Antofagasta, Chile.

Right: A station setup for table-top observing, photographed by Robert E. Cox.

Below: Pointing a telescope in altitude by means of a protractor level.



REGISTRATION OF ADDITIONAL MOONWATCH STATIONS

Location	*Leader*	*Address*	*Sponsor*
Athens, Ga.	Charles V. Powell	Box 2241, Georgia Univ. Station, Athens, Ga.	Univ. of Georgia Physics Club
Terre Haute, Ind.	Nunz Addabbo	P. O. Box 1108, Terre Haute, Ind.	Terre Haute First National Bank and Allis Chalmers Mfg. Co.
New Orleans, La.	Prof. J. F. Thomson	139 South Genois St., New Orleans, La.	Tulane University
Silver Spring, Md.	G. R. Wright	202 Piping Rock Dr., Silver Spring, Md.	
Detroit, Mich.	Henry Malone	19171 Meyers Road, Detroit, Mich.	
Dover, N. J.	C. Richard Mallett	215 No. Beverwyck Rd., Lake Hiawatha, N. J.	Picatinny Arsenal
Red Bank, N. J.	Marvin Bernstein	80 Belshaw St., Eatontown, N. J.	
Buffalo, N. Y.	Edward Lindberg	492 Shirley Ave., Buffalo 15, N. Y.	
Schenectady, N. Y.	Russell W. Carter	902 Delamont Ave., Schenectady, N. Y.	Schenectady Astronomy Club and Instrument Society of America
Floydada, Tex.	Fred Zimmerman, Jr.	522 West Kentucky St., Floydada, Tex.	
Waco, Tex.	George E. Miles	3828 Huaco Lane, Waco, Tex.	Phillips Petroleum Co.
		PACIFIC OCEAN AREAS AND SOUTH AMERICA	
Truk, East Caroline Islands	Richard S. Baker	Weather Bureau Airport Station, Truk, East Caroline Islands, Pacific	
Wake Island	John R. Berger	Weather Bureau, Wake Island, Pacific	
Yap, Western Carolines	Moses R. Burrows, Jr.	Weather Bureau Office, Yap, Western Carolines, Pacific	
Sydney, Australia	G. Patston	42 Lincoln St., Belfield, New South Wales, Australia	
Antofagasta, Chile	Rev. German E. Saa, S.J.	Casilla 591, Antofagasta, Chile	Colegio San Luis
Santiago, Chile	Dr. E. P. Heilmaier K.	Casilla 6014, Santiago de Chile	Catholic University of Chile
		JAPAN	
Asahigawa	Yoshio Domoto	Asahigawa Observatory, Asahigawa-shi, Hokkaido	Astronomical Society of Japan and Mainichi Press
Fukuoka	Tsutomu Sakanoue	Kyushu-Daigaku Nogakubu, Dote-machi 20, Fukuoka-shi	Astronomical Society of Japan and Mainichi Press
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Kurumemachi	Hideo Inoue	No. 64, 450, 4-Chome, Hyakunincho, Tokyo	Japan Astronomical Study Association and Tokyo Yomiuri Press
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Nakatsu	Shigeru Nakano	Inebori-machi, Nakatsu-shi, Oita-ken	Astronomical Society of Japan and Mainichi Press
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BOOKS AND THE SKY

SPECTROSCOPY AT RADIO AND MICROWAVE FREQUENCIES

D. J. E. Ingram. Philosophical Library, New York, 1956. 332 pages. $15.00.

OPTICAL SPECTROSCOPY has long been an important source of basic physical knowledge, but only during the last two or three decades has our knowledge been extended to the radio end of the spectrum. Despite this comparatively late start, tremendous progress has been made, particularly since 1945.

Although it is an ambitious undertaking in a book as short as this, the author has attempted to summarize both the techniques employed and the results obtained in all phases of radio and microwave spectroscopy up to mid-1955. The book is clearly intended for those who are familiar with quantum mechanics, and should provide a useful, over-all view of the field for those who have a background in astrophysics, physics, or chemistry.

The techniques used and materials studied by radio and microwave methods are certainly varied. For example, absorption spectra in the wave-length range from a millimeter to a few centimeters are obtained by both microwave spectroscopy and magnetic resonance experiments. In the former, gases are usually the object of interest, the observed spectrum relating primarily to the properties of individual free molecules, while in the latter case the interactions of atoms, ions, or free radicals with their environment, usually a solid or liquid, are the most common subject of study. In the microwave spectroscope, magnetic or electric fields can be applied to give small perturbations of the observed lines, but in the case of magnetic resonance, the applied magnetic field has a major effect on the spectrum.

In either instance, information about the atomic nucleus can also be gained, whenever the small interaction between the nucleus and the atom or molecule in which it resides results in an observable hyperfine structure. On the other hand, nuclear resonance and molecular beam experiments are often concerned with the nuclear properties directly, the interaction of the nuclear electric and magnetic fields with their surroundings and with external fields providing the principal features of the observed spectrum, while the specifically atomic or molecular effects are often of secondary interest.

It is not surprising that the author is most complete when dealing with his own field of magnetic resonance, although the other branches of the subject receive treatment in separate chapters. In view of the recent utilization of paramagnetic resonance techniques to produce amplifiers and oscillators of radically different design (the solid-state maser), this is a good emphasis, since the other books now available in this field have emphasized gaseous spectroscopy. In a concluding chapter on applications of radio-frequency spectroscopy, astronomy of the 21-cm. hydrogen line receives two pages. Unfortunately, a misleading statement is made in this section about radio sources being identified with bright optical stars, when in fact our sun is the only star so far identified as a radio source.

The introductory chapters on experimental techniques provide a general survey of microwave methods, but some poor proofreading is evident in several of the circuit diagrams, in which errors appear that would prevent the circuits from working. It is to the author's credit, however, that each chapter is provided with a comprehensive list of references, and these undoubtedly could prove one of the most valuable features of the book for a student seriously interested in pursuing some phase of this new branch of spectroscopy.

B. F. BURKE
Carnegie Institution of Washington

THE MILKY WAY

Bart J. Bok and **Priscilla F. Bok.** Harvard University Press, Cambridge, Mass., 1957. 264 pages. $5.50.

COMPARED WITH its two predecessors, this third edition of *The Milky Way* is an entirely new book. The Boks have not only rewritten their earlier work but they have reillustrated it with superior material that has become available in the last few years. However, the general arrangement of the book, one of the Harvard series on astronomy, remains almost the same.

After the reader is first introduced to the Milky Way, he becomes acquainted with the tools and data of observation. The sun's nearest neighbors are treated next, and then the authors conduct the reader on a tour of our galaxy. In four successive chapters the galactic tourist gets to know the organization of stars and their population characteristics, the motions of the stars and the rotation of the galaxy, the interstellar gas, dark nebulae, and cosmic dust.

There is an excellent and welcome account of radio astronomy and its contributions to galactic studies. The ninth chapter brings together the evidence for the galaxy's spiral structure; finally, evolutionary changes in the galactic system are discussed.

While it is easy for the layman or amateur to understand, the book is authoritative and will serve as a handy reference for the teacher of astronomy who desires to check quickly certain recent data for his lectures. The chapter on radio astronomy reflects Professor Bok's special interest in this field, revealing his facility for removing the radio tech-

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by Henry C. King

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[1]E. Opik, *Irish Astronomical Journal.*
[2]Harlan J. Smith, *American Scientist.*
[3]John F. Heard, RASC *Journal.*
[4]Frank K. Edmondson, *Science.*

Eastern Hemisphere Publishers: Chas. Griffin, London

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Harvard Observatory, Cambridge 38, Mass.

nician's jargon and stressing the astronomical aspects of the situation.

The publisher calls attention to the fact that no conventional type or engravings were used, all the text being photocomposed and the printing done by photo-offset. Apparently this is a way of cutting costs without making the book inferior. Only six typographical errors were found by this reviewer.

In general, this latest edition is superior to the earlier ones. The organization of material is better and the beautiful illustrations have been used advantageously in bringing out points in the text. The reader obtains a grand picture of our Milky Way system and its structure without getting lost in technical details. The Boks express themselves in an absorbing fashion that surmounts the subject's difficulties. Their fluency is a welcome relief from the stilted prose of many recent popular books on astronomy.

ROBERT T. MATHEWS
Goodsell Observatory
Carleton College

NEW HORIZONS IN ASTRONOMY

Fred L. Whipple, editor. U. S. Government Printing Office, Washington 25, D. C., 1956. 181 pages. $1.50, paper bound.

IN PUBLISHING this book the Smithsonian Astrophysical Observatory has done a great service to astronomical research. For 39 fields of astronomy and related sciences, experts describe the trends in current research and suggest profitable directions for future study.

The papers are arranged under four headings: "Techniques and Instrumentation," "Related Sciences," "Solar System," and "Stars and the Galaxy." Typical titles are "Solar Instrumentation," "Rocketry," "Meteors," and "Globular Clusters Observed Through a Crystal Ball."

These are not review articles, for they are directed toward the future rather than the past. In general each writer tries in three or four pages to list the research needs of his field and to suggest projects that are likely to be most fruitful. The individual articles are necessarily short, one or two much too brief, but many of them contain a wealth of stimulating ideas.

For the professional astronomer, this volume serves a double purpose. In his own field, the stocktaking by other experts provides an intellectual challenge and provokes new ideas. In less familiar subjects, these articles often illuminate current lines of development whose significance is not readily apparent from the highly specialized papers scattered through the technical journals.

Although *New Horizons in Astronomy* is written primarily for the research astronomer, others will profit from reading it. The teacher will find here a bird's-eye view of some of those topics whose classroom presentation periodically needs to be brought up to date. The advanced student will likewise profit from the emphasis on the questions confronting modern astronomy. How often, in any discipline, the student is taught the answers before he appreciates the questions! Finally, although many of the articles are highly technical, the amateur astronomer has here a rare chance to see the professionals in their working surroundings.

It is the emphasis on ideas for future study that gives this collection its major appeal. The process of developing working hypotheses is a basic link in the chain of scientific progress, but it often lies hidden. The reasons are sound enough—shortage of space in technical journals and the natural reluctance of conservative scientists to publish unsubstantiated opinions. Yet a science grows by cross-fertilization of ideas, and anyone who wishes to understand this growth should sample the ideas. I do not mean to suggest that this book is full of bold speculations, for it presents carefully considered opinions directed toward practical research projects.

The publication of *New Horizons in Astronomy,* which is Vol. 1, No. 1 of the *Smithsonian Contributions to Astrophysics,* was supported in part by the National Science Foundation. The foundation has also provided for its distribution to all members of the American Astronomical Society. It cannot fail to stimulate astronomical progress.

IVAN R. KING
University of Illinois Observatory

NEW BOOKS RECEIVED

LES RAYONS COSMIQUES, *André Cachon, Alice Daudin,* and *Louis Jauneau,* 1957, *Presses Universitaires de France,* 108 Boulevard Saint-Germain, Paris 6, France. 116 pages. Paper bound. No price given.

Research on cosmic rays, from the first discoveries in 1900 through recent developments, is summarized for readers who already have some acquaintance with physics. Written in French, this small book is No. 729 of the *Que sais-je?* series on the arts and sciences.

LIGHT, VEGETATION AND CHLOROPHYLL, *J. Terrien, G. Truffaut,* and *J. Carles,* 1957, *Philosophical Library.* 228 pages. $6.00.

Two studies, translated from the French by Madge E. Thompson, describe the effect of light on vegetation and crops, and the chemistry of chlorophyll and of photosynthesis. These are important aspects of the problem of supplying food and energy to a rapidly increasing world population.

A SHORT DICTIONARY OF MATHEMATICS, *C. H. McDowell,* 1957, *Philosophical Library.* 103 pages. $2.75.

Definitions and brief explanations of some terms used in elementary mathematics are collected here for the student and beginner. It is arranged in dictionary form, one section for arithmetic and algebra, another for plane trigonometry and geometry.

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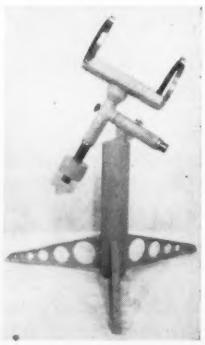

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Maksutov Telescope Notes

INTEREST in the Maksutov telescope is continuing to increase, as its neat design and fine performance have aroused amateur enthusiasm everywhere. The author of our March article, John Gregory, has received inquiries from many foreign countries, especially in South and Central America. The Maksutov club of Allan M. Mackintosh, Glen Cove, New York, has already oversubscribed the first special lot of 50 corrector shells for the 11¼-inch diameter lenses.

Six f/15 Cassegrainian-Maksutov telescopes of the type designed by Mr. Gregory are under construction by members of the Amateur Telescope Makers of Boston, as are five of the f/23 design. These shells were curve-generated with a diamond wheel to a close tolerance, so that once the proper jigs are constructed only fine grinding and polishing need to be done.

Many readers have inquired as to which of the Gregory designs is the best to construct. If a worker has made only one or two mirrors, or if all his optical experience has been with long radii, f/8 or longer, then the f/23 is the better shell to attempt. With experience in making f/4 or similar short-focus reflectors, one should be capable of the f/15 design. As the longer radii of the f/23 Maksutov will be easier to grind and test, such a telescope will probably be finished and placed in operation sooner. Planetary observers will prefer the f/23, for its long focal length gives high power with medium-focus eyepieces and comfortable eye relief. The smaller secondary spot will intercept less light, permitting a greater amount to be concentrated in the image.

In Mr. Gregory's original designs for Cassegrainian-Maksutovs, the aperture was chosen as six inches, with the mirror sizes 6.6 and 6.4 inches for the f/15 and the f/23, respectively. Many amateurs would prefer an aperture slightly less than six inches, so the mirror could be made from a standard pyrex blank. The new set of figures given here has 6-inch mirrors for both instruments. Readers are referred to the March issue, page 237, for the diagram that goes with this data.

As with the original design, concentricity of the shells should be held to 0.001″ or less. With a diameter of the lens of less than six inches, it should be easy to obtain a satisfactory blank from the war-surplus listing given in the original article (page 239).

Can one obtain molded shells of optical glass for the Gregory-Maksutov design? We have discussed this problem with the Hayward Scientific Glass Corp., whose sales manager is James L. Wood. To avoid the expense of making two complete sets of molds for the original f/15 and the f/23 designs, he proposes providing blanks with one radius from each design. This means that one surface will require a minimum of grinding; the other, on a 6-inch lens, will need about 1/8″ of stock removed from the edge of the lens. However, this will be easy compared to starting with a flat blank.

For other sizes, the Gregory design was scaled, from the original 6-inch figures, to fit 4-, 5-, 8-, and 10-inch clear-aperture instruments. Only the specifications for the 6-inch size are given here, but amateurs can obtain a complete listing of glass supplies for 4- to 10-inch instruments from the Hayward Scientific Glass Corp., 217 Magnolia Ave., Whittier, Calif., by sending with each request a stamped self-addressed envelope.

The glass for the molded corrector shells will be Hayward fine annealed BSC-2 (517645), and the specifications for the 6-inch aperture are: diameter, 6.650; R_1 (1st lens surface), −6.483; R_2 (2nd lens surface), −8.393; central thickness, 0.741; weight, 2.86 pounds.

The diameter of the lens exceeds the largest given size for the f/15 by 0.2″. This will allow ample material for edging, but if the glass cleans up with more than 0.15″ for mounting, it is recommended that the excess be kept. This will permit

CASSEGRAINIAN-MAKSUTOV TELESCOPE SPECIFICATIONS

(All dimensions are in inches)

Symbol	*Characteristic*	*f/15*	*f/23*
D_c	Diameter of correcting lens	5.877	5.878
T_c	Thickness of correcting lens	0.492 ± 0.010	0.420 ± 0.010
D_m	Diameter of primary mirror	6.00	6.00
T_m	Thickness of primary mirror	1.0	1.0
D_s	Diameter of secondary spot	1.27	1.12
D_h	Diameter of hole in primary mirror	1.25	1.0
R_1	Radius of curvature of 1st lens surface	−5.984 ± 0.070	−7.538 ± 0.070
R_2	Radius of curvature of 2nd lens surface	−6.262 ± 0.070	−7.775 ± 0.070
R_3	Radius of curvature of primary mirror	−28.03 ± 0.50	−40.68 ± 0.50
R_4	Radius of curvature of secondary spot	−6.262 ± 0.070	−7.775 ± 0.070
CA	Clear aperture of correcting lens	5.454	5.625
BA	Back aperture of correcting lens	5.727	5.728
S	Separation of lens and mirror	11.697	17.382
BFL	Back focal length	15.60	21.609
	Effective focal length	81.82	131.25

a larger mounting lip, and will probably include in the unused area most or all of the turned-up or turned-down edge zone that one encounters in figuring steep shells; this will simplify considerably the working of the back surface.

For the original f/15, the first radius is −6.583″; as a Hayward molded blank with −6.483″ is steeper, it will start to grind at the edge first if worked with a tool shaped approximately to the correct curve. Smoothing the curve will not remove glass from the center of the lens and will leave a maximum of control in grinding the lens to the finished thickness. Putting a 6.888″ convex curve on the back surface with its −8.393″ radius will remove only edge stock, so this curve can also be roughed in fairly close without removing any thickness from the center. On the f/23, with R_1 only −8.040″, the edge will be ground to obtain the altered curve—also on the back surface, where the desired radius of −8.293″ is steeper than the −8.393″ of the molded glass. The central thickness of the blank is 0.741″, a fifth of an inch over the finished figure, giving ample material for the less experienced amateur to work with. Hayward has set the following prices on molded blanks for 6-inch correctors: 1 blank, $26; 5 blanks, $23.50 each; 10, $22.25 each; 20, $19.75 each; all postpaid. For prices of other sizes, consult their listing. Payment should accompany each order and quantity shipments should go to one address.

As the manufacturer must keep correspondence about Maksutov blanks to a minimum, and cannot assist in design problems, it is suggested that amateur telescope making groups in various sections of the United States act as distributors of the lens blanks, thereby facilitating their procurement at the lower quantity prices. We will give notice in this department if informed of any such arrangements; the Amateur Telescope Makers of Boston have already planned to act for the New England area.

In the March article, Mr. Gregory pointed out that the primary mirror of a Cassegrainian-Maksutov should be of pyrex or other low-expansion glass. In addition to the Corning series and the Hayward 5-inch blanks mentioned there, amateurs can now obtain mirror blanks suitable for the original Gregory designs. The glass is Hayward C-3 (508610), and comes in sizes for Maksutovs from 4 to 10 inches in aperture. For the Gregory design of 6-inch aperture, the diameter is 6.7″, thickness 1.25″, weight 3.96 pounds, and the cost $10.75 postpaid. Specifications for other sizes will be given with the Hayward listing of corrector shell blanks already mentioned.

Much working time can be saved if the surfaces of a corrector blank are curve-generated with a diamond wheel before grinding begins. This also gives better control of final wedge, radii of curvature, and lens thickness. Mr. Gregory has therefore built a curve-generating machine at his home at 1202 Hope St., Springdale, Conn., and offers to perform this service for amateurs and groups aiding in the distribution of Maksutov supplies. He will curve-generate a molded Hayward 6-inch blank for his f/15 design at $40, for the f/23 design at $49. For quantities (all one design or the other), the cost is: f/15, 5 blanks, $38 each; 10, $36; 20, $34; and for f/23, 5, $46; 10, $44; 20, $42. Payment should accompany each order.

The curves will be generated to within 0.005″ of the correct sagitta or closer, with a surplus of 0.030″ per surface left for smoothing and fine grinding. Each lens will be edged perfectly round to its finished diameter. In the case of war-surplus glass stock (such as available from Edmund Scientific Corp. or A. Jaegers), for example 6½″ square by 32 mm. thick, finished as either f/15 or f/23 to the specifications listed for the molded blanks, Mr. Gregory will charge: 1 blank, $56; 5, $50 each; 10, $46; 20, $44.

Diamond surfacing of mirror blanks also saves considerable work in any kind of telescope. Mr. Gregory will generate to curve a 6.7-inch Hayward C-3 blank, perforate it, and make the back surface flat and at right angles to the optical axis at $21 per mirror, $20 each for five alike, $19 for 10, $18 for 20.

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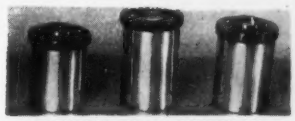

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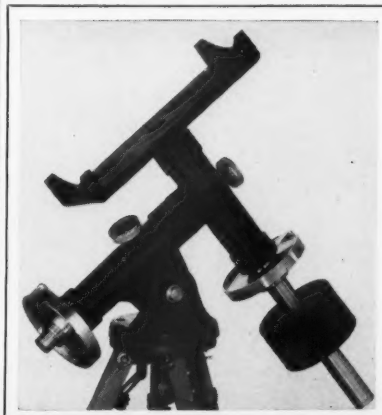

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above optical elements can also be obtained upon request from the A. D. Jones Optical Works, 2400 Massachusetts Ave., Cambridge, Mass. We will be glad to announce services of a similar nature by other organizations or individuals.

Further word on Maksutov activities will appear in a future issue. Advanced amateurs interested in this subject are invited to correspond with this department of *Sky and Telescope*.

R. E. C.

HOW TO COLLIMATE A REFRACTING TELESCOPE

THE OWNER of a refractor who wants the best performance from his instrument should collimate or align its objective from time to time. For this adjustment, most refractors have three or four push-pull screws fastening the objective cell to the tube.

Many amateurs test collimation by looking at the diffraction rings surrounding a star to see if they are central. The following method may be carried out in daylight and is much easier. With care, it has nearly the same sensitivity as the diffraction-ring method.

The only equipment needed is a flat mirror, about 2" by 3", from which the silvering has been removed over a central area about ¼" across. The mirror does not have to be of optical quality.

If the instrument is to be adjusted indoors, its objective end should be pointed toward a sunlit window. Cap the objective so that no light can enter it from the front, and remove the eyepiece, leaving the drawtube in place.

Hold the mirror some 12" or 18" back of the drawtube to reflect light up the telescope tube, and look through the clear spot in the mirror toward the objective. You will see a circular white spot (this is the drawtube opening reflected from the back of the objective) and also the reflection of the hole in the mirror. If the objective is properly squared on, there is only one white spot visible, and it is concentric with the drawtube and also the objective.

But if the objective is not accurately collimated, two smaller white spots will appear alongside the larger one. These are the three reflections from the three convex surfaces of the objective lens components. In this case, turn the adjusting screws in such a way that the objective is brought closer to you on the side where the smaller spots appear. Repeat this process until all that is seen is one large white spot, containing both smaller ones, and concentric with the hole in the mirror.

These directions apply to objectives of the Fraunhofer type. For a Steinheil-type objective, one with the flint component in front, the adjusting screws must be turned in the opposite direction.

ASTROLA Reflecting Telescopes

AMERICAN MADE

STANDARD MODEL "A", 6-inch **$295.00**
STANDARD MODEL "B", 8-inch **$375.00**
STANDARD MODEL "C", 10-inch **$475.00**

The above instruments are fully portable — as they can be assembled or taken down in three minutes. Each comes with three of the finest oculars. The equatorial head and stand are of cast aluminum; the tube is of fiberglass. Optics are corrected to ⅛ wave or better and are quartz coated. Clock drives, rotating tubes, setting circles furnished at additional cost.

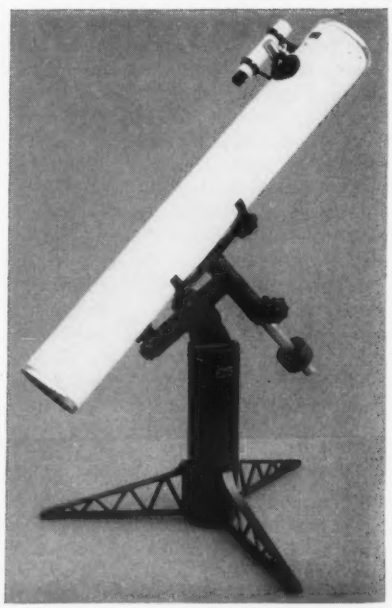
Pyrex mirrors with diagonals are sold separately if desired:

6" with diagonal — aluminized and quartz coated ..... **$ 60.00**
8" with diagonal — as above ..... **$ 92.50**
10" with diagonal — as above **$160.00**

The ASTROLA telescopes will resolve double stars to the Dawes limit. If you are not satisfied with the performance of the mirror in your present telescope, we will refigure, aluminize, and coat it at a reasonable price.

All prices F.O.B. our plant, Long Beach, Calif., and subject to change without notice.

CAVE OPTICAL COMPANY
4137 E. Anaheim St., Long Beach 4, Calif.



Standard Model "A" 6-inch ASTROLA, f/8, complete with 3 oculars (72x, 180x, 315x)
$295.00

pushing away from you the side of the objective on which the smaller spots appear.

With a 4-inch refractor, it is hard to align the white spots closer than about 1/8". But if the telescope is to be used for close double stars, the adjustment must be made with all possible care.

No particular novelty can be claimed for this method of squaring on an objective, for it was in use as early as the 18th century. It does not seem to be as widely known among amateurs as it deserves to be.

CHESTER J. SMITH
9775 Burgos Ave.
Oakland 5, Calif.

COLLIMATING A REFLECTOR IN A JIFFY

IN MAKING an 8-inch Newtonian reflector, I used a method for aligning the primary mirror and diagonal that is much simpler than the process described by Allyn J. Thompson in *Making Your Own Telescope*, page 120.

The mirror cell and its support should have been so constructed that the mirror and tube are exactly concentric. The mirror's center is marked with a heavy cross of black ink before it is placed in the tube. This cross need not be later removed, as it is shadowed by the diagonal and will not interfere with the telescope's performance.

Rather strong background illumination is necessary—the sky or a well-lighted room. Two fine threads are stretched diametrically across the upper end of the tube, to mark its center. Look into the tube from a distance of a foot or more. If the cross threads and the mark on the mirror do not coincide, this can easily be brought about by the adjusting screws on the mirror cell.

It is a simple matter to align the spider, if this is already in place, by bringing its central hole into line with the cross threads and the mark on the mirror. (If you wish to offset the diagonal mirror to cause it to match the reflected cone, as explained on page 115 of Thompson's book, this may be accomplished at the same time.)

Finally, place a cross mark on the diagonal like that on the primary mirror (but be sure it is removable), and put crosshairs in the eyepiece adapter tube. Insert the diagonal mirror and bring these three intersections into coincidence, thereby completing the adjustments for collimation. After removal of the two sets of crosshairs and the cross from the surface of the diagonal, the telescope is ready for use.

CHARLES J. WRIGHT
515 28th Ave.
San Francisco 21, Calif.

TRIPLES 'SCOPE PERFORMANCE!

Sharper images, wider field, more light at higher powers! A startling statement positively proven in 16-page telescopic educational matter sent free on receipt of self-addressed long envelope bearing nine cents (9c) return postage.

First, the Goodwin Resolving Power lens placed in front of eyepiece gives three times the magnification on each by lengthening your primary focal length angle up to three times, yet extends eyepiece out no more than two inches from normal. This alone sharpens definition.

Next, by achieving your highest powers on more comfortable low-power eyepieces, you lessen image deteriorations due to short-focus acute bending of the convergent beam, since all usual eyepieces are f/1 or less. Again sharper images from this highest precision lens.

Third, you get greater illumination and wider field by relieving tiny aperture restrictions of higher-power eyepieces.

The Resolving Power lens is achromatic, coated, gives flat field sharp to the edge. Here is astonishment! Price $17.50 in 4" long adapter tube fitting standard 1¼" eyepiece holders ONLY (also adaptable to Unitrons. State if Unitron). Money back if not positively thrilled after two weeks trial! Used and praised by legions!

No COD's — Colleges and Observatories may send purchase order.

FRANK GOODWIN
345 Belden Ave., Chicago 14, Ill.

Own the MOST modern . . . MOST desirable refractor in the world today.

HY-SCORE Goto
4" Equatorial Refractor
with Clock Drive

HY-SCORE Goto refractors are GUARANTEED to be fully corrected for astigmatism, spherical aberration, coma, and will give resolution of double stars to Dawes' theoretical limit.

COMPLETE
$995.00 f.o.b. Brooklyn
Fully guaranteed. Complete with instructions.

Precision engineered and incorporating the latest scientific advances for astronomical observation, this fine 4" Equatorial Refractor offers you:

- MOUNTING. A modern equatorial with complete 360° rotation of its slow motions in *both* right ascension and declination; remote-control handles operate smooth worm gears on both axes.
- EYEPIECES. Four of these, each fully corrected and coated: Mittenzwey-Huygens 6-mm. giving 250x; 12.5-mm. for 120x; 25-mm. for 60x; and a Keliner 40-mm. giving 38x.
- ACHROMATIC OBJECTIVE. Focal length 1,500 mm.; resolving power 1.16 seconds of arc; shows stars as faint as magnitude 11.8.
- STANDARD EQUIPMENT includes achromatic removable view finder, 22-mm., 7x, with crosshair focusing; rack-and-pinion main focusing; star and sun diagonal prism; sunglass; sun projecting screen; electric driving clock; wooden cabinet; *rugged* tripod with equipment table.

If your dealer cannot supply you, your check will be honored and immediate shipment made.

Whether you are an amateur, professional, or are connected with an educational institution, there is a HY-SCORE Goto refractor to fit your discerning needs. Prices range from **$75 to $4975.**

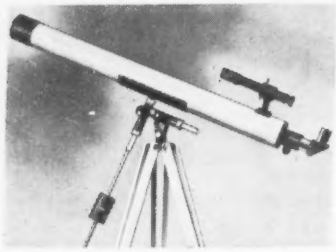
SEND FOR FREE CATALOGUE

See full-page Goto advertisement on page 437.

HY-SCORE Goto Scientific Instrument Division
S. E. LASZLO

DEPT. 10—25 LAFAYETTE STREET,
BROOKLYN 1, NEW YORK

3″ ASTRONOMICAL REFRACTOR TELESCOPE



A good-looking, complete instrument, ready to use. Reveals the wonders of the sky in sharp, clear detail. The 3″ air-spaced achromatic objective (low-reflection coated) has been tested by experienced observers who pronounce it equal to any you can buy at reasonable cost. An excellent telescope at an amazingly low price. Rack-and-pinion eyepiece holder of cast aluminum—focusing tube of chrome-plated brass. Takes standard 1¼″ eyepieces. We supply two eyepieces and a Barlow lens, giving powers of 40X, 90X, 120X, 270X. Star diagonal for easy viewing. Optical finder telescope, 6-power, with crosslines. Hardwood tripod, 60″ long. Equatorial mounting makes following a star very easy. FREE STAR CHART AND STAR BOOK INCLUDED.

Stock #85,032-Y ..... **$125.00** f.o.b.
(Shipping wt. 30 lbs.) Barrington, N. J.

3″ "PALOMAR, JR." REFLECTOR

60- to 120-Power — An Unusual Buy!

Assembled—ready to use! See Saturn's rings, the planet Mars, huge craters on the moon, star clusters, moons of Jupiter, galaxies! Nonbreakable aluminum-covered tube. Equatorial mount with lock on both axes. Aluminized and over-coated 3″ diameter f/10 primary mirror, ventilated cell. Telescope comes equipped with a 60X eyepiece and a mounted Barlow lens, giving you 60 to 120 power. A finder telescope, always so essential, included. Sturdy, hardwood, portable tripod.

Free with scope: Valuable STAR CHART and 136-page ASTRONOMY BOOK.

Stock #85,050-Y ..... **$29.50** f.o.b.
(Shipping wt. 10 lbs.) Barrington, N. J.

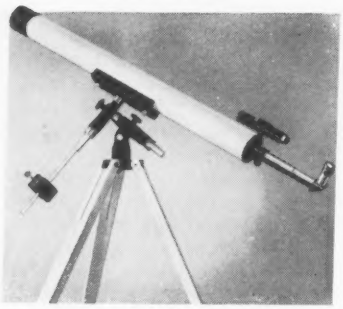
SPITZ MOONSCOPE

A precision-made 32-power reflecting telescope —by makers of Spitz Jr. Planetarium. Clearly reveals the craters of the moon, shows moons of Jupiter, other wonders of the heavens. Based on same principles as world's giant telescopes. Stands 36″ high on removable legs. Adjustable 3″ polished and corrected mirror. Fork-type altazimuth mount rotates on full 360° circle — swings to any location in the sky. Fascinating 18-page instruction book; sturdy carrying case.

Stock #70,068-Y ..... **$14.95 ppd.**

4″ REFRACTOR TELESCOPE

240-POWER

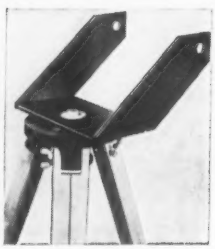


Complete with Finder, Equatorial Mounting, Tripod, Eyepiece Extension, Star Diagonal, and Three Eyepieces

Our newest development. Built for rugged use, quality performance. Mounting made from heavy iron castings with machined bearings for smooth operation. Tripod has extra-heavy 60″ hardwood legs. Telescope's weight is 42 lbs., giving stable, steady viewing. Big 4″ objective is an air-spaced achromat, each element coated on both sides for low reflection. Three eyepieces supplied give you 48X, 120X, and 240X. Special Barlow lens also gives up to 500X. Star diagonal included for comfortable viewing at high angles. Rack-and-pinion focusing. All metal parts are plated to prevent rusting. Finder is 8 power. The usual price for a 4″ refractor of comparable quality is over $400, so our new model saves you almost 40%.

Stock #85,038-Y ..... **$247.00** f.o.b.
(Shipping wt. 55 lbs.) Barrington, N. J.

LOW-COST TRIPOD AND ALTAZIMUTH MOUNT



Put your telescope to use as soon as it's finished, by using this mount. Later you can remove the offset yoke and bolt an equatorial mounting of pipe fittings or other parts to the tripod head. Or, if you don't need a portable telescope, buy only the offset yoke to bolt to a post in the ground. Takes tubing up to 7½″ outside diameter. The yoke is made of ¼″-thick painted steel plate. The tripod head is machined cast iron, 6½″ diameter, gray wrinkle. The three sturdy hardwood legs are 32″ long.

Tripod and Offset Yoke
Stock #85,037-Y **$19.95**

Offset Yoke only
Stock #85,042-Y **$9.95**

Tripod Head and Legs only
Stock #85,043-Y **$12.50**

All above items are f.o.b. Barrington, N. J.

WAR-SURPLUS TELESCOPE EYEPIECE

Mounted Kellner Eyepiece, Type 3. 2 achromats, F.L. 28 mm., eye relief 22 mm. An extension added, O.D. 1¼″, standard for most types of telescopes. Gov't. cost $26.50.

Stock #5223-Y ..... **$7.95 ppd.**

EDSCORP SATELLITE TELESCOPE

THE STORY: From the beginning of the visual satellite program, Edmund Scientific Co. was consulted by the Coordinator of Visual Satellite Observations of the Smithsonian Astrophysical Observatory in order to find existing optical instruments or to help in the development of new ones to meet the unique requirements of MOONWATCH. Every effort was to be made to get an instrument with the greatest possible field, which would still have the ability to observe faint objects with only moderate magnification. All this was to be provided at a minimum cost. More than thirty different optical arrangements were examined and evaluated by expert advisors to the MOONWATCH program. The optics which we have used have been described in the *Bulletin for Visual Observers of Satellites* as providing one of the best combinations for the purpose.

OPTICS: The Satellite Scope has two important optical characteristics: A wide (51-mm.) diameter, low-reflection-coated objective lens. A six-element extremely wide-field, coated Erfle eyepiece that, in combination with the objective, gives 5.5 power with a big 12° field and over 7-mm. exit pupil.

MOUNT: The mount came in for special attention because of unique requirements of group observing. The center of rotation of the instrument is just below the point where the optical axis is deflected by the front-surface mirror. The mirror is set at 45° to the axis of the telescope barrel and reflects light at exactly 90°. Side brackets and wing nuts permit fast, easy elevation and rigid locking. Rubber eyeguards and the angle of the telescope permit the greatest comfort in long-time viewing. The wide field and our special mount permit the utmost coverage of the possible passage of the satellite, without omission of an area of the sky, by a string of observers.

OTHER USES FOR THE SATELLITE SCOPE

1. Makes a perfect wide-field finder. A special groove on the barrel helps in locating it in the finder mount. Fits our twin-ring finder mount, Stock No. 70,079-Y—$9.95. **2.** Use the Erfle eyepiece on your regular astronomical telescope. You will need our adapter, Stock No. 30,171-Y—$3.95, which gives you an O.D. of 1¼″. This eyepiece cost the government $56.00! **3.** Makes a wonderful comet seeker; see complete asterisms. **4.** Makes a fine rich-field telescope; see wide areas of sky with deep penetration.

Especially Made for Members of MOONWATCH
Stock #70,074-Y ..... **$49.50 ppd.**

ATTENTION!

Here's an Interesting "Do-It-Yourself" Project

If you want to build your own Satellite Scope, we can supply the optical parts, or any metal parts from our assembled Satellite Scope. We'll be glad to send you full description of these components together with price information.

WRITE FOR SATELLITE BULLETIN #40-Y

ASTRONOMICAL TELESCOPE TUBING

Stock No.	I.D.	O.D.	Lgth.	Description	Price
80,038-Y	4⅞″	5¼″	46″	Spiral-wound paper	$2.50
85,008-Y	6⅞″	7⅜″	60″	Spiral-wound paper	4.00
85,011-Y	2⅞″	3″	48″	Aluminum	6.00
85,012-Y	3⅞″	4″	60″	Aluminum	8.75
85,013-Y	4⅞″	5″	48″	Aluminum	9.00
85,014-Y	6⅞″	7″	60″	Aluminum	15.00

All tubing is shipped f.o.b. Barrington, N. J.

EDMUND SCIENTIFIC CO.

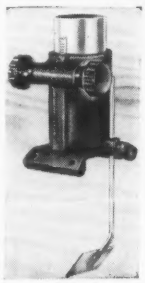
WAR-SURPLUS KELLNER EYEPIECE

Mounted — Ready to Use — 1¼" Outside Diameter — Coated — 1¼" Focal Length

Consists of an achromatic eye lens and an achromatic doublet field lens (Gov't. cost about $30). The clear aperture of the lenses is approximately 1", giving wide exit pupil and a clear image. Excellent for any telescope when low power and a wide field are needed. Try it for 10 days — if you don't agree that the performance is better than any commercial type selling for two or three times our price, we will refund your money in full.

Stock #50,130-Y ..... $5.90 ppd.

Rack & Pinion Eyepiece Mounts



For Reflectors

For Refractors

Now you can improve performance in a most important part of your telescope — the eyepiece holder. Smooth, trouble-free focusing will help you to get professional performance. Look at all these fine features: real rack-and-pinion focusing with variable tension adjustment; tube accommodates standard 1¼" eyepieces and accessory equipment; lightweight aluminum body casting; focusing tube and rack of chrome-plated brass; body finished in black wrinkle paint. No. 50,077-Y is for reflecting telescopes, has focus travel of over 2", and is made to fit any diameter or type tubing by attaching through small holes in the base. Nos. 50,103-Y and 50,108-Y are for refractors and have focus travel of over 4". Will fit our 2⅞" I.D. and our 3⅞" I.D. aluminum tubes respectively.

Stock #50,077-Y (less diagonal holder) $9.95 ppd.
Stock #60,035-Y (diagonal holder only) 1.00 ppd.
Stock #50,103-Y (for 2⅞" I.D. tubing) 12.95 ppd.
Stock #50,108-Y (for 3⅞" I.D. tubing) 13.95 ppd.

HUYGENS EYEPIECES

Here are some really terrific values in eyepieces! The three eyepieces listed below are manufactured by one of the world's best producers of optical components. We have searched the world's markets, including Germany and France, to find a real quality eyepiece. The image clarity, the workmanship evidenced in the metal parts, will prove the skill and experience of Goto Optical Company, Tokyo. Guaranteed terrific buys!

HUYGENS TYPE — STANDARD 1¼" DIAMETER
6-mm. (¼") Focal Length
Stock #30,063-Y ..... $8.50 ppd.

12.5-mm. (½") Focal Length
Stock #30,064-Y ..... $8.00 ppd.

COMBINATION EYEPIECE — 10-mm. and 20-mm.
Stock #30,065-Y ..... $9.00 ppd.

7X — FINDER TELESCOPE — ACHROMATIC

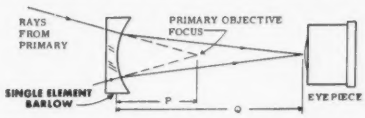
Stock #50,080-Y Finder alone, less ring mounts $9.95
Stock #50,075-Y Ring mounts per pr. $3.95

HEAVY-DUTY EQUATORIAL MOUNT AND TRIPOD for 6"-8" REFLECTING TELESCOPE

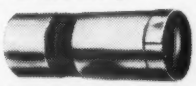
Heavy cast base with sturdy 32" long hardwood legs. 1" shafts. Boston bronze bearings to provide a uniform film of lubrication over entire bearing surface and assure smooth operation. Big locking knobs 1¾" on both declination and polar axes. Polar axis variable for latitude adjustment. 12" cradle securely holds 3" to 10" tubes. Beautifully finished in baked black wrinkle paint. Legs can be removed easily for permanent post mounting. Height 38", weight 32 lbs.

Stock #85,023-Y ..... $49.50 f.o.b.

DOUBLE AND TRIPLE YOUR TELESCOPE'S POWER WITH A BARLOW LENS



WHAT IS A BARLOW? A Barlow lens is a negative lens used to increase the power of a telescope without resorting to short focal length eyepieces, and without the need for long, cumbersome telescope tubes. Referring to the diagram above, a Barlow is placed the distance P inside the primary focus of the mirror or objective. The Barlow diverges the beam to a distance Q. This focus is observed with the eyepiece in the usual manner. Thus, a Barlow may be mounted in the same tube that holds the eyepiece, making it very easy to achieve the extra power. The new power of the telescope is not, as you might suppose, due to the extra focal length given the objective by the difference between P and Q. It is defined as the original power of the telescope times the quotient of P divided into Q!



Beautiful chrome mount. We now have our Barlow lens mounted in chrome-plated brass tubing with special spacer rings that enable you to vary easily the power by sliding split rings out one end and placing them in other end. Comes to you ready to use. Just slide our mounted lens into your 1¼" I.D. tubing, then slide your 1¼" O.D. eyepieces into our chrome-plated tubing. Two pieces provided, one for regular focal length eyepieces and one for short focal length ones.

Remember, in addition to doubling and tripling your power, a Barlow lens increases your eye relief and makes using a short focal length eyepiece easier.

Don't fail to try one of these. Many people do not realize the many advantages of a Barlow and the much greater use they can get from their telescopes. Our Barlow has a focal length of —1⅝6". We have received many complimentary letters about this lens. So sure are we that you will like it that we sell it under a 30-day guarantee of satisfaction or your full purchase price returned — no questions asked. You can't lose, so order today.

Stock #30,200-Y Mounted Barlow lens $8.00 ppd.

ATTENTION — BEGINNERS AND JUNIOR ASTRONOMY CLUBS

To solve the problem of low-cost lenses of good quality for a beginner's telescope we have had these achromatic lenses designed and mass produced. Our first shipment is in. They are swell!

ACHROMATIC OBJECTIVE, 32-mm. diameter (1¼"), F. L. 31". (Will get 62X with ½" eyepiece; 124X with ¼" eyepiece.)

Stock #30,201-Y ..... $2.50 ppd.

ACHROMATIC OBJECTIVE, 42-mm. diameter (1-21/32"), F.L. 41". (Will get 41X with 1" eyepiece; 82X with ½"; and 164X with ¼".)

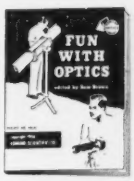
Stock #30,202-Y ..... $4.00 ppd.

PRISM STAR DIAGONAL

For comfortable viewing of the stars near the zenith or high overhead on refractor telescopes using standard size (1¼" O.D.) eyepieces, or you can make an adapter for substandard refractors. Contains an excellent quality aluminized right-angle prism. Tubes are satin chrome-plated brass. Body is black wrinkle cast aluminum. Optical path of the system is about 3½".

Stock #70,077-Y ..... $12.00 ppd.

FUN WITH OPTICS



New booklet, 32 pages. Completely illustrated. Shows you how to build many types of optical instruments; plus lens primer showing various types of lenses and how they work, optical illusions, etc.

Simple, easy-to-follow directions for building astronomical telescopes, terrestrial telescopes, artist's drawing projectors, reflex slide viewers, magnifiers, miniature monoculars, transparency projectors and many other optical instruments.

No technical knowledge is needed. Youngsters or grownups can have a lot of fun learning about optics and building their own optical instruments using lenses, prisms, etc., purchased from us.

Stock #9050-Y ..... $.50 ppd.

"MAKE-YOUR-OWN" 4¼" MIRROR KIT

The same fine mirror as used in our telescopes, polished and aluminized, lenses for eyepieces and diagonal. No metal parts.

Stock #50,074-Y ..... $16.25 ppd.

6X FINDER TELESCOPE

Has crosshairs for exact locating. You focus by sliding objective mount in and out. Base fits any diameter tube — an important advantage. Has 3 centering screws for aligning with main telescope. 20-mm. diam. objective. Weighs less than ½ pound.

Stock #50,121-Y ..... $8.00 ppd.

MISCELLANEOUS ITEMS

KELLNER EYEPIECE — 2" focal length (1¼" O.D.) Mount of black anodized aluminum.

Stock #30,189-Y ..... $6.00 ppd

60° SPECTROMETER PRISM — Polished surfaces 18 mm. x 30 mm. — flat to ½ wave length.

Stock #30,143-Y ..... $8.25 ppd.

BRASS TUBING

2 pieces, 3" long, slide fitting. Blackened brass. I.D. 1-3/16". O.D. 1-5/16".

Stock #40,165-Y ..... $1.75 ppd

30-day Money Back Guarantee as with all our Merchandise!

BE SURE TO GET FREE CATALOG "Y"
Fantastic variety—never before have so many lenses, prisms, optical instruments, and components been offered from one source. Positively the greatest assembly of bargains in all America. Imported! War Surplus! Hundreds of other hard-to-get optical items. Write for Free Catalog "Y."

ORDER BY STOCK NUMBER . . . SEND CHECK OR MONEY ORDER . . . SATISFACTION GUARANTEED!

BARRINGTON • NEW JERSEY

Follow the Stars Wherever You Go

with a BALscope TELESCOPE

Now you can enjoy astronomy whenever you wish—wherever you are, thanks to the excellent portability of the BALscope 60mm telescope. Why, it's so compact (16½" long, weighs 48 ounces) you can carry it anywhere, and it can be mounted on any pan-head camera tripod with a B&L tripod adapter.

Focusing the BALscope is simple yet precise with its unique prism-focusing system. Its high light-gathering power and lack of stray light enables you to observe stars down to the tenth magnitude on moonless nights. Four easily interchangeable eyepieces ranging from 15X to 60X provide excellent results—from Star Clouds to Double Stars. Of course, you'll find the BALscope is also the finest terrestrial telescope available.

BAUSCH & LOMB TIME PAYMENT PLAN

You can own the BALscope for just pennies a day under new Time Payment Plan offered by B&L dealers everywhere.

$6.18 per mo.
$115 cash price

WRITE for free copy of G-36, "The Telescope." Tells all about the BALscope and how it is so ideally suited to amateur astronomy. Tells also of many ways your family will enjoy the BALscope.
Bausch & Lomb Optical Co.,
25819 Lomb Pk., Rochester 2, New York.

BAUSCH & LOMB
SINCE 1853

OBSERVER'S PAGE

Universal time is used unless otherwise noted.

Observations of the May 5th Transit of Mercury

On the afternoon of May 5th, four deputy sheriffs stopped their car near Alpine, California, to check on a suspicious stranger. He identified himself as R. M. Lippert, of San Diego, and invited the law-enforcement officers to look through the telescope he had set up to watch the transit of Mercury. They were impressed by the sight of the tiny, jet-black disk in silhouette against the brilliant face of the sun.

This was the third transit of Mercury Mr. Lippert had seen, but the first time he had noted the black drop—the dark ligament appearing to connect the planet and the sun's edge, as Mercury is entering or leaving the solar disk. Mr. Lippert looked for but did not see any halo around the planet, or bright spot on it, two appearances occasionally noted at previous transits.

As explained on page 280 of the April issue, Mercury's entry upon the sun could be seen from all but the easternmost parts of the United States, as a late afternoon event. However, the sun set before the transit ended, except in the Far West, the only part of the country where the entire 2½-hour duration was observable. A transit of Mercury is usually longer than this, but the planet traversed a relatively short chord across the north polar region of the sun.

Reports have come in from observers as widely separated as Ohio and the Philippines. For cases where it is specifically stated that WWV time signals or their equivalent were used, the table gives the observed contact times. Because of the grazing nature of Mercury's ingress and egress, these contact times do not have the same value for fixing the relative positions of the planet and the sun as did timings at the previous transit, in November, 1953. Mrs. Simone Gossner, U. S. Naval Observatory, points out that the *American Ephemeris* has been using prediction formulae that are less accurate for grazing than for central transits.

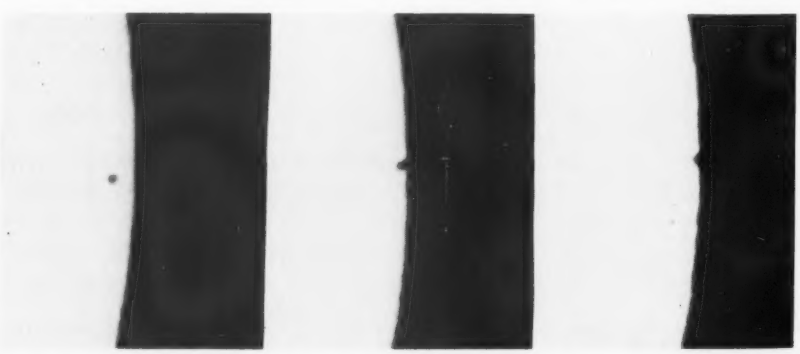
Still and motion pictures were attempted at Kneeland Prairie, near Eureka, California, where 35 members and friends of a newly organized club, the Astronomers of Humboldt, watched the transit with four reflecting telescopes, all masked to apertures of two inches.

Few observers reported seeing the black drop. In part, this may have been due to the mediocre seeing resulting from the low altitude of the afternoon sun. D. McCandless, Dayton, Ohio; M. Francis, Bellwood, Illinois; and B. Mabrito, San Antonio, Texas, all state that during their observations of Mercury's ingress little or nothing of a black-drop effect was seen.

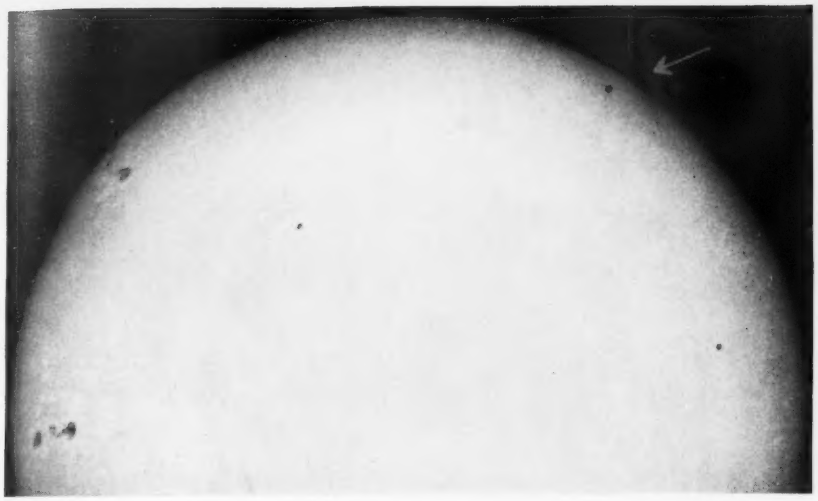
At Long Beach, California, however, Philip Peters recorded it distinctly in a series of drawings he made to illustrate the gradual entry of Mercury onto the solar disk, as seen with his 8-inch reflector. As the planet advanced from minute to minute, it gradually became pear-shaped, connected to the sun's edge by a narrow dark ligament. It was the moment of rupture of this ligament, when sunlight could first be seen all around the planet, that Mr. Peters recorded as contact II.

As Mercury was leaving the sun's disk, after third contact, the black drop was clearly seen by Charles Gardiner, at San Jose, California, with 225x on a 2.4-inch refractor. Others in the observing group at the B and C Observatory used the projection method and recorded contact times somewhat earlier than Mr. Gardiner's.

At Buttonwillow, California, while making drawings and taking pictures, Franklin J. Kosdon and Blain Perry found Mercury to be considerably darker



At the observatory of the Taiwan weather bureau at Taipei, pictures of the transit were taken by Yeou-tswen Ting with a 4-inch equatorial refractor. Universal times of the sequence above, showing the egress of Mercury from the sun's disk, are (left to right) 2:08:21, 2:23:38, and 2:25:46. The exposures were 1/50, 1/200, and 1/100 second, through a yellow filter, with the telescope's lens stopped down to about half its aperture. The emulsion was Agfa 33, and the timing was done with a chronometer.



The transit of Mercury, photographed by Hans Arber in Manila at 1:30 UT, May 6, 1957. The planet, near the north point of the sun's disk and indicated by the arrow, appears much darker and sharper than the umbrae of sunspots of similar size.

than any of the nearby spots on the sun.

Dale P. Cruikshank, at Des Moines, Iowa, used his 12-inch f/8 reflector at full aperture and a Brower solar filter. He recorded WWV 10-megacycle time signals with a tape recorder, and pressed a telegraph key to give an audible signal for the contact time, via a transistor radio oscillator.

Three members of the Saskatoon Astronomical Society, in Saskatchewan, Canada, watched their first transit of Mercury. They used the 7-inch refractor at the University of Saskatchewan, projecting an image of Mercury about four millimeters in diameter. In spite of turbulent atmospheric conditions, they timed the second contact with an estimated accuracy of two seconds. Third and fourth contacts, occurring with the sun just above the horizon, were obscured by a nearby building.

A heliostat and lens combination with a focal length of 40 feet, giving a 4½-inch solar image, was used by R. N. Bracewell and G. Vurek, at the Radio Propagation Laboratory of Stanford University in California. The apparatus was originally made for a transit of Venus expedition, and is at present on loan from Lick Observatory for watching sunspots in connection with radio propagation studies. The observers timed all four contacts.

The transit was well observed in the Philippine Islands, and H. Arber at Manila took successful pictures with his 6-inch refractor. He used an orange filter, a neutral density filter No. 10, and a projection lens of 40 millimeters focal length, giving a solar image size of over four inches. With this arrangement and a Thornton focal-plane shutter (protected with a 2-inch Compur shutter), Mr. Arber has taken many pictures of details in sunspots.

In Victoria, Australia, J. P. Hamilton received observations of the transit by several amateurs. In Melbourne, the sky was cloudy for the ingress, but at least five observations were made there of the last two contacts. Mr. Hamilton is in his fourth year as editor of the *Journal* of the Astronomical Society of Victoria, which has about 280 members, practically all amateurs.

MERCURY TRANSIT, MAY 5-6, 1957, UNIVERSAL TIMES OF CONTACTS

Place and Observers	*Instrument*	*Method*	*II*	*III*	*IV*
Dayton, Ohio					
David McCandless and Dennis Macci	2.4″ refractor	100x	00:05:56	——	——
Bellwood, Ill.					
Jack Cadogan, M. Francis, David and Millard Wells	6″ reflector 4″ reflector	Proj.	00:06:07	——	——
Des Moines, Iowa					
Dale P. Cruikshank and Robert Curnutt	12″ reflector	160x	00:04:04	——	——
San Antonio, Tex.					
Bruce Mabrito and Georgia Lee Riley	4″ reflector	Proj.	00:07:15	——	——
Saskatoon, Canada					
T. Beck, S. A. Brown, and L. A. Chester	7″ refractor	Proj.	00:06:15	Obscured	Obscured
Long Beach, Calif.					
Philip Peters	8″ reflector	Proj.	00:08:25	Obscured	Obscured
Buttonwillow, Calif.					
Franklin J. Kosdon and Blain Perry	5″ reflector 4″ reflector	116x 150x	00:06:45	02:19:45	——
San Jose, Calif.					
Stephen Bieda, Jr.	2.4″ refractor	225x	——	02:18:49	02:27:50
Robert Cunningham, Jerry Estruth, Charles Gardiner, Margaret Krumm, and James Styczynski	1¼″ reflector 6″ reflector	Proj.	——	02:18:30	02:27:41
Stanford, Calif.					
R. N. Bracewell and G. Vurek	Heliostat, 40′ lens and mirror	Proj.	00:06:58	02:18:14	02:26:41
Kneeland Prairie, Calif.					
"Astronomers of Humboldt"	Reflectors	——	00:06:23	02:19:57	02:28:36

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Junior astronomers at Seattle viewed the eclipse by projection with an 8-inch reflector. On the screen may be seen the "bite" made in the sun's image by the moon. Holding the screen is Tom Peterson, while Alex Cameron and Mike Young are in the background. James Young is at the right, and Jerry Patton took the picture.

Partial Solar Eclipse Observed in Northwest

FINE WEATHER in the northwestern states enabled amateurs to have a good view of the partial eclipse of the sun on the late afternoon of April 29th. T. P. Maher, Portland, Oregon, timed the last contact of the moon with the sun at 6:09:22 Pacific standard time. In the Seattle, Washington, area, photographs were taken by Dominic Vautier, at St. Edward's Seminary, Kenmore, and by a group of junior astronomers led by James W. Young.

An Edmund elbow telescope was used by Mr. Vautier to project an image of the sun about 20 inches in diameter in a darkened room. He could see clearly about 8 to 10 sunspots, and "at about 5:07 p.m. noticed a slight dent in the sun's disk which slowly grew in size and grandeur."

Upon getting home from school, Mr. Young, with the assistance of his brother Mike, Alex Cameron, Jerry Patton, and Tom Peterson, set up an 8-inch reflector, altazimuth mounted. This instrument was on loan from Bill Hillman, of the Seattle Amateur Astronomical Society. A small Bausch and Lomb refractor and a short-wave radio receiver for time signals completed the equipment. That evening some 25 persons came to Mr. Young's home to see Comet Arend-Roland.

SATURN OCCULTS A STAR

During the morning hours of April 28th, Saturn passed in front of the 8th-magnitude star BD −20° 4568. Predictions of this unusual phenomenon were given on page 302 of the April issue, and on page 351 for May. Several observers have sent in reports.

At Richmond, Virginia, the occultation was watched in six telescopes by members of the Richmond Association of Junior Astronomers, according to a report by Prof. E. C. Hoff, Medical College of Virginia. As seen in an 8-inch reflector, power 150x, the star gradually approached the edge of the outer ring, and remained for about five minutes as a tiny projecting bead of light. Its disappearance was timed as 2:37:35 a.m. EST. Afterward, the star could not be seen through the outer ring A.

Arnold Nieuwenhoff and Frank Abbott, of the Aldrich Astronomical Society, observed the occultation with a 10-inch reflector, 370x, at Worcester, Massachusetts. By 2:30 a.m. the star was very close to the ring and hard to see. Twenty minutes later only occasional glimpses of the star could be obtained and it was last noted at 2:58.

Lunar Crescent Sets

These 10 Lick Observatory pictures are a matching series to Moon Sets, but for the waxing crescent 4½ days after new moon, and the waning crescent about five days before new moon.

The first two pictures show each crescent as a whole, and key charts are included to identify the lunar features, especially those near the moon's edge that are shown to better advantage than in Moon Sets. Four pictures are closeups of the waxing crescent, four of the waning; these may be cut out and put together to form mosaic crescents in which the moon's diameter is about two feet.

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54 mm (2⅛")	762 mm (30").....	12.50	108 mm (4¼")	914 mm (36").....	60.00
54 mm (2⅛")	1016 mm (40").....	12.50	110 mm (4⅜")*	1069 mm (42⅛").....	60.00
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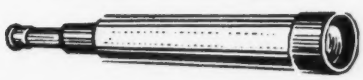

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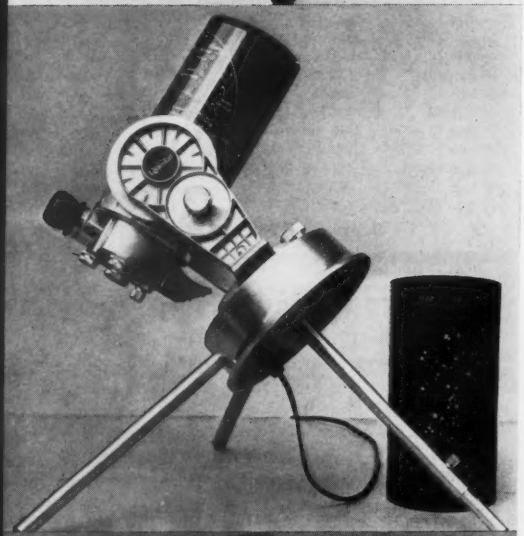

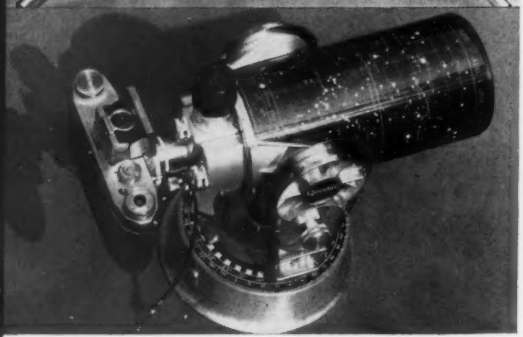

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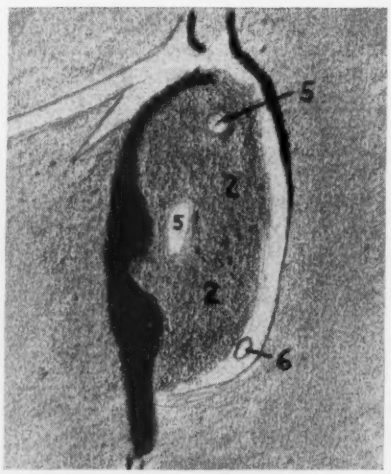
THE HERODOTUS PUZZLE

As far back as 1887, a curious central bright spot was observed in the lunar crater Herodotus by C. M. Gaudibert, who described it as "a very faint and fugitive whiteness." This report went long unnoticed, until James C. Bartlett, Jr., saw the phenomenon again in November, 1949, and in June and July of the following year. H. P. Wilkins observed it in March, 1950. Dr. Bartlett described this elusive marking in an article, "Herodotus, A Light That Failed," in the July-August, 1954, issue of the *Strolling Astronomer,* and there was a further discussion by D. W. Rosebrugh in the November-December, 1954, number of that periodical.

On November 15, 1956, at 1:18 UT, only three days before the widely observed total eclipse of the moon, Dr. Bartlett again recorded the Herodotus central bright spot, in a drawing copied here. On the same night at 2:00 UT, I independently drew Herodotus, but did not see the spot. From this it appears that the visibility of the white marking may depend very sensitively on the positions of the sun and the observer with respect to the crater.

Other amateurs may have been observing the same portion of the moon



A copy of a drawing by James C. Bartlett of the lunar crater Herodotus, made with a 3½-inch reflector at 100x under good seeing conditions. The numbers denote relative brightness on a scale of 0 to 10. The bright spot under discussion is near the center of the crater's floor.

that night, possibly in preparation for the eclipse. Drawings or good-quality photographs of Herodotus on the night of last November 14-15 would be of value, whether or not they show the spot. They should be submitted to Dr. James C. Bartlett, Jr., 300 N. Eutaw St., Baltimore 1, Md.

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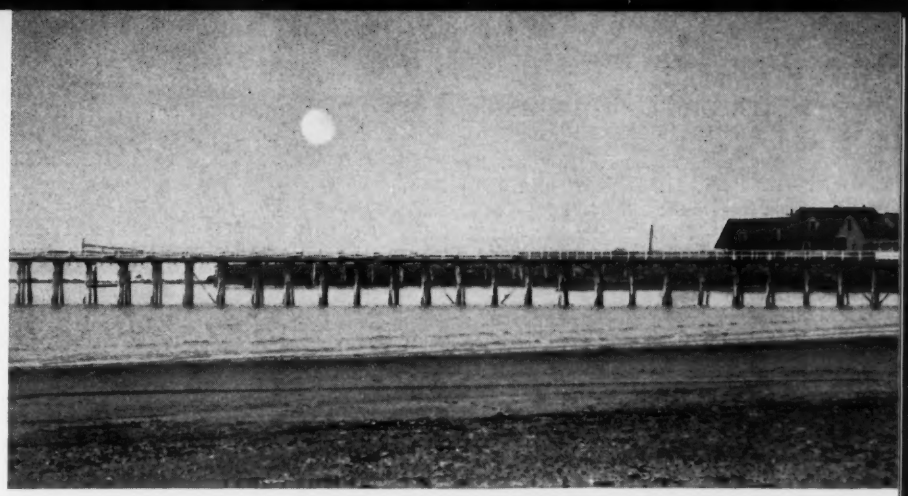

The partially eclipsed rising moon on May 13th was mostly clouded out along the East Coast of the United States, but at Revere Beach, Massachusetts, this picture was taken as the moon cleared the murky horizon haze at 7:10 p.m. Eastern standard time. Seven minutes later the umbral eclipse ended, but penumbral darkening was very noticeable.

SUNSPOT NUMBERS

April 1, 113, 140; **2,** 127, 156; **3,** 132, 135; **4,** 132, 156; **5,** 150, 138; **6,** 136, 108; **7,** 137, 138; **8,** 164, 160; **9,** 160, 163; **10,** 143, 150; **11,** 117, 121; **12,** 117, 114; **13,** 97, 143; **14,** 93, 122; **15,** 124, 162; **16,** 190, 181; **17,** 187, 202; **18,** 193, 205; **19,** 180, 207; **20,** 198, 208; **21,** 188, 218; **22,** 195, 212; **23,** 226, 226; **24,** 229, 248; **25,** 209, 251; **26,** 183, 223; **27,** 198, 213; **28,** 188, 223; **29,** 180, 177; **30,** 151, 155. Means for April: 161.2 American, 175.2 Zurich.

Above are given the date, the American number, then the Zurich number. These are observed mean relative sunspot numbers, the American computed by Dr. Sarah J. Hill from AAVSO Solar Division observations, the Zurich numbers from Zurich Observatory and its stations in Locarno and Arosa.

Predictions of the smoothed monthly sunspot numbers have been supplied by Dr. M. Waldmeier for the coming months: August, 149; September, 145; and October, 142.

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PREDICTIONS OF BRIGHT MINOR PLANET POSITIONS

Antigone, 129, 9.7. July 21, 21:43.2 −12·34; 31, 21:36.8 −13·59. August 10, 21:29.2 −15·28; 20, 21:21.4 −16·56; 30, 21:14.5 −18·14. September 9, 21:09.3 −19·18.

Eunike, 185, 9.4. July 31, 22:48.1 −3·47. August 10, 22:44.2 −5·50; 20, 22:38.5 −8·15; 30, 22:31.7 −10·50. September 9, 22:24.7 −13·24; 19, 22:18.6 −15·45.

Hebe, 6, 7.4. July 31, 22:33.5 −10·59; August 10, 22:29.7 −13·17; 20, 22:23.8 −15·51; 30, 22:16.8 −18·27. September 9, 22:09.9 −20·49; 19, 22:04.6 −22·42.

Pax, 679, 9.3. July 31, 22:31.9 −31·19. August 10, 22:29.6 −35·30; 20, 22:24.2 −39·19; 30, 22:17.3 −42·28. September 9, 22:10.4 −44·46; 19, 22:05.3 −46·09.

After the asteroid's name are its number and the magnitude expected at opposition. At 10-day intervals are given its right ascension and declination (1950.0) for 0^h Universal time. In each case the motion of the asteroid is retrograde. Data are supplied by the IAU Minor Planet Center at the University of Cincinnati Observatory.

MINIMA OF ALGOL

July 2, 3:14; 5, 0:02; 7, 20:51; 10, 17:40; 13, 14:28; 16, 11:17; 19, 8:06; 22, 4:54; 25, 1:43; 27, 22:31; 30, 19:20. August 2, 16:08; 5, 12:57.

These minima predictions for Algol are based on the formula in the 1953 *International Supplement* of the Krakow Observatory. The times given are geocentric; they can be compared directly with observed times of least brightness.

LUNAR MAP

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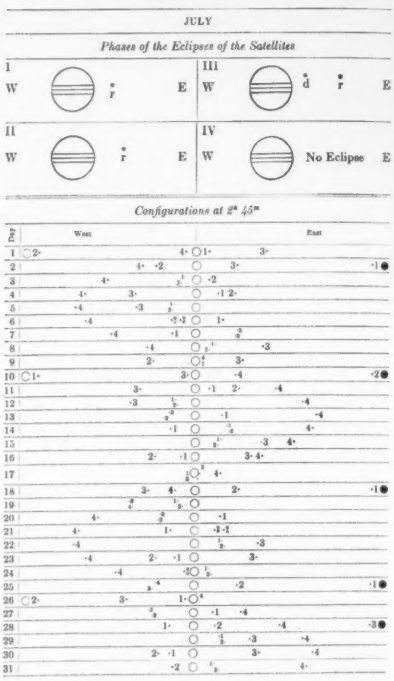
Harvard Observatory, Cambridge 38, Mass.

JUPITER'S SATELLITES

The configurations of Jupiter's four bright moons are shown below, as seen in an astronomical or inverting telescope, with north at the bottom and east at the bottom of the satellite in Jupiter's shadow; *r* is the point of reappearance.

In the lower section, the moons have the positions shown for the Universal time given. The motion of each satellite is from the dot toward the number designating it. Transits over Jupiter's disk are shown by open circles at the left, eclipses and occultations by black disks at the right. The chart is from the *American Ephemeris and Nautical Almanac.*



OCCULTATION PREDICTIONS

July 7·8 **Omega**[1] **Scorpii** 4.1, 16:04.3 −20·33.3, 10. Im: **I** 6:49.3 −1.6 −1.8 143.

For stations in the United States and Canada, usually for stars of magnitude 5.0 or brighter, data from the *American Ephemeris* and the *British Nautical Almanac* are given here, as follows: evening-morning date, star name, magnitude, right ascension in hours and minutes, declination in degrees and minutes, moon's age in days, immersion or emersion; standard station designation, UT, **a** and **b** quantities in minutes, position angle on the moon's limb; the same data for each standard station westward.

The **a** and **b** quantities tabulated in each case are variations of standard-station predicted times per degree of longitude and of latitude, respectively, enabling computation of fairly accurate times for one's local station (long. **Lo**, lat. **L**) within 200 or 300 miles of a standard station (long. **LoS**, lat. **LS**). Multiply **a** by the difference in longitude (**Lo** − **LoS**), and multiply **b** by the difference in latitude (**L** − **LS**), with due regard to arithmetic signs, and add both results to (or subtract from, as the case may be) the standard-station predicted time to obtain time at the local station. Then convert the Universal time to your standard time.

Longitudes and latitudes of standard stations are:

A	+72°.5,	+42°.5	**E**	+91°.0,	+40°.0
B	+73°.6,	+45°.5	**F**	+98°.0,	+31°.0
C	+77°.1,	+38°.9	**G**	Discontinued	
D	+79°.4,	+43°.7	**H**	+120°.0,	+36°.0
			I	+123°.1,	+49°.5

UNIVERSAL TIME (UT)

TIMES used on the Observer's Page are Greenwich civil or Universal time, unless otherwise noted. This is 24-hour time, from midnight to midnight; times greater than 12:00 are p.m. Subtract the following hours to convert to standard times in the United States: EST. 5; CST, 6; MST, 7; PST, 8. If necessary, add 24 hours to the UT before subtracting, in which case the result is your standard time on the day preceding the Greenwich date shown.

SKY-GAZERS EXCHANGE

Classified advertising costs 20 cents a word, including address; minimum charge, $3.00 per ad. Only one *for sale* ad per issue for each advertiser. *Remittance must accompany order.* Insertion is guaranteed only on copy received by the 20th of the second month before publication; otherwise, insertion will be made in next issue. We cannot acknowledge classified ad orders. Sky Publishing Corporation assumes no responsibility for statements made in classified ads, nor for the quality of merchandise advertised. Write Ad Dept., *Sky and Telescope,* Harvard Observatory, Cambridge 38, Massachusetts.

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BEGINNER'S Telescope Kit: $3.00 each, all parts, and 3 lenses. Make 8-power astronomical telescope described in September, 1949, *Sky and Telescope.* Frank Myers, 19200 N. Park Blvd., Shaker Heights, Ohio.

4.5″ REFRACTOR, custom-built by Fecker, portable, like new, 7 x 35 finder, heavy tripod, alt-azimuth head, slow motions with remote controls, metal parts cast brass, black finish, objective in push-pull collimating cell, 40″ focal length for maximum light, five oculars (25x to 250x), cost about $1,000.00. Best offer or trade for Questar like new. Customer preferred Cleveland area. Enclose reply envelope. T. Doran, 373 East 288th St., Willowick, Ohio.

WANTED: Portable motor-driven equatorial 8″ to 12″ reflector. J. C. McDonald, 4212 Concord St., Midland, Mich.

SYNCHRONOUS MOTORS in stock. 1/2,000 horsepower to ¼ horsepower. Speeds available from ½ revolution per day to 3,600 revolutions per minute. Request free literature. Minarik Electric Co., 224 E. Third St., Los Angeles 13, Calif.

WILL BUY, if real bargain and good usable condition, second-hand large altazimuth instrument reading seconds of arc (or at least 10 seconds). Want pendulum sidereal clock, mercury barometer, precision bubble level, technical astronomical books and star catalogues. F. Buch, Alpes 324 Lomas, Mexico, D. F., Mexico.

SCHMIDT'S famous moon map, 25 plates. Printed on 8½″ x 11″ sheets. $1.75, postpaid world-wide. Scientific Book Service, 663 Franklin Ave., Columbus 15, Ohio.

BOOKS WANTED: The following wanted in new or good used condition: *The Telescope,* Louis Bell; *Lunettes et Telescopes,* Danjon and Couder; *The Adjustment and Testing of Telescope Objectives,* published by Cooke; *Die Theorie der Optischen Instrumente,* Czapski and Eppenstein. State price and condition. Box A, *Sky and Telescope,* Harvard Observatory, Cambridge 38, Mass.

SIDEREAL DRIVE plans for telescope or camera, accurate simple gearless design; make color transparencies; complete plans for $1.00. "Space Chart" of sun, moon, planets, asteroids, graphically proportioned, also constellation maps listing many stars, $1.00. L. Mussgnug, Box 74, Bethel, Conn.

8″ CIRCLES: Beautifully printed. 720 divisions for mounting on disks cut by you. Complete instructions. $6.00 per pair. B. A. Stevens, 2011 LaMesa, Dodge City, Kans.

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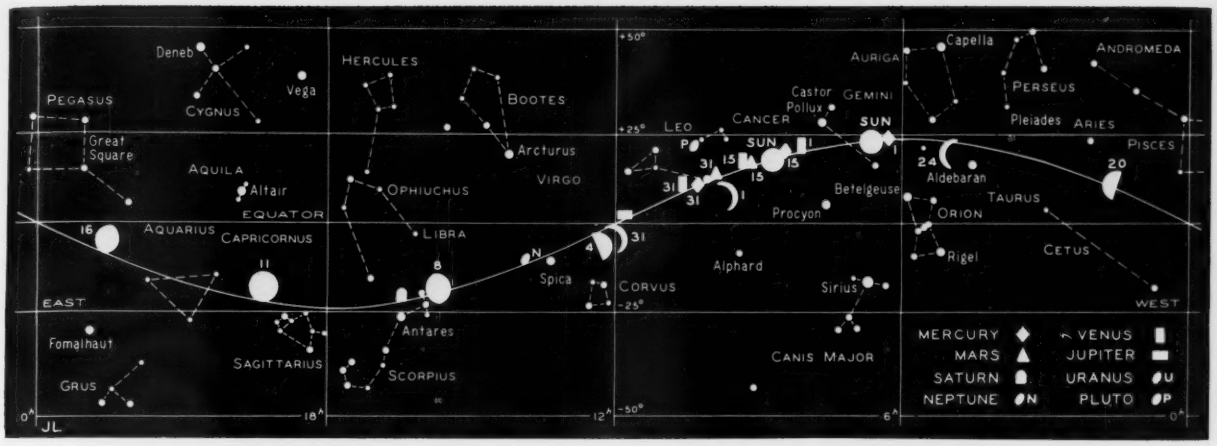

THE SUN, MOON, AND PLANETS THIS MONTH

The sun, on the ecliptic, is shown for the beginning and end of the month. The moon's symbols give its phase roughly, with the date marked alongside. Each planet is located for the middle of the month or for other dates shown. All positions are for 0^h Universal time on the respective dates.

In mid-July, all eight principal planets will be above the horizon in the evening sky just after sunset. On the 15th, the naked-eye planets are, from west to east, Mercury, Mars, Venus, Jupiter, and Saturn, with the first two reversing their order on July 23rd.

Mercury may be seen in the evening twilight during the latter half of July. The planet sets about one hour after the sun, appearing at zero magnitude. On July 29th, Mercury passes about $\frac{1}{4}°$ north of Regulus in Leo.

Venus sets about $1\frac{1}{2}$ hours after sundown, shining at magnitude -3.3. On the night of July 6-7, the planet travels through the middle of the open cluster Praesepe, in Cancer, at which time two close conjunctions will occur. At 21^h UT, Venus will pass 30″ from the 6.5-magnitude star 40 Cancri, and at 5^h UT on the 7th the planet will be 21″ from 110B Cancri (magnitude 7.0). On the 25th, Venus may be observed only $1\frac{1}{4}°$ north of Regulus.

On July 15th, the planet's disk is 11″ in diameter and 91-per-cent illuminated.

Earth reaches the aphelion point of its orbit on July 3rd, when its distance from the sun is greatest, 94,500,000 miles.

Mars disappears into the sun's glare at the end of the month. Appearing as a 2nd-magnitude object, Mars may be seen 25′ south of Venus on July 11th.

Jupiter, also in the evening sky, sets three hours after the sun on the 15th. On this same date, Jupiter is once more in conjunction with Beta Virginis, passing 36′ north. The giant planet, moving eastward through Virgo, is shining at magnitude -1.4.

Saturn will be on the meridian during evening twilight, setting after midnight. The planet is in retrograde motion, about 6° north of the star Antares. On the 15th, the magnitude of Saturn is $+0.4$, and its ring system is inclined 25°.8 to our line of sight.

Uranus will be unobservable in July, as it arrives at conjunction with the sun on the 30th.

Neptune is at eastern quadrature with the sun on July 23rd, and will set about midnight. This remote planet changes from retrograde to direct motion on the 12th, and thus will appear nearly stationary all month, about $4\frac{1}{2}°$ west of Kappa Virginis. E. O.

JULY METEORS

The maximum activity of the Delta Aquarids, one of the more vigorous meteor showers, occurs on July 29th, but some members of this swarm may be seen about a week before and after that date. Moonlight will not interfere, as new moon is on the 27th. The radiant of these medium-speed meteors at the time of maximum activity is 22^h 36^m, $-17°$. The predicted rate of all meteors seen by a single observer is 20 per hour after midnight, but it should be greater for lower latitudes. E. O.

VARIABLE STAR MAXIMA

July 3, R Canum Venaticorum, 134440, 7.7; 5, U Herculis, 162119, 7.6; 6, Chi Cygni, 194632, 5.3; 10, R Bootis, 143227, 7.3; 10, V Bootis, 142539, 7.9; 10, U Ceti, 022813, 7.5; 12, RT Cygni, 194048, 7.4; 20, W Andromedae, 021143, 7.5; 20, RV Centauri, 133155, 7.6; 23, V Cassiopeiae, 230759, 7.9; 25, R Cygni, 193449, 7.3; 29, RS Cygni, 200938, 7.4; 29, S Virginis, 132706, 7.1.

August 4, X Monocerotis, 065208, 7.6; 6, RS Scorpii, 164844, 6.8; 9, S Ursae Majoris, 123961, 7.9.

These predictions of variable star maxima are by the AAVSO. Only stars are included whose mean maximum magnitudes are brighter than magnitude 8.0. Some, but not all of them, are nearly as bright as maximum two or three weeks before and after the dates for maximum. The data given include, in order, the day of the month near which the maximum should occur, the star name, the star designation number, which gives the rough right ascension (first four figures) and declination (bold face if southern), and the predicted magnitude.

MOON PHASES AND DISTANCE

First quarter	July	4, 12:09
Full moon	July	11, 22:50
Last quarter	July	20, 2:17
New moon	July	27, 4:28
First quarter	August	2, 18:55

	July	Distance	Diameter
Apogee	16, 3^h	251,900 mi.	29′ 28″
Perigee	28, 10^h	223,400 mi.	33′ 14″
	August		
Apogee	12, 14^h	252,400 mi.	29′ 23″

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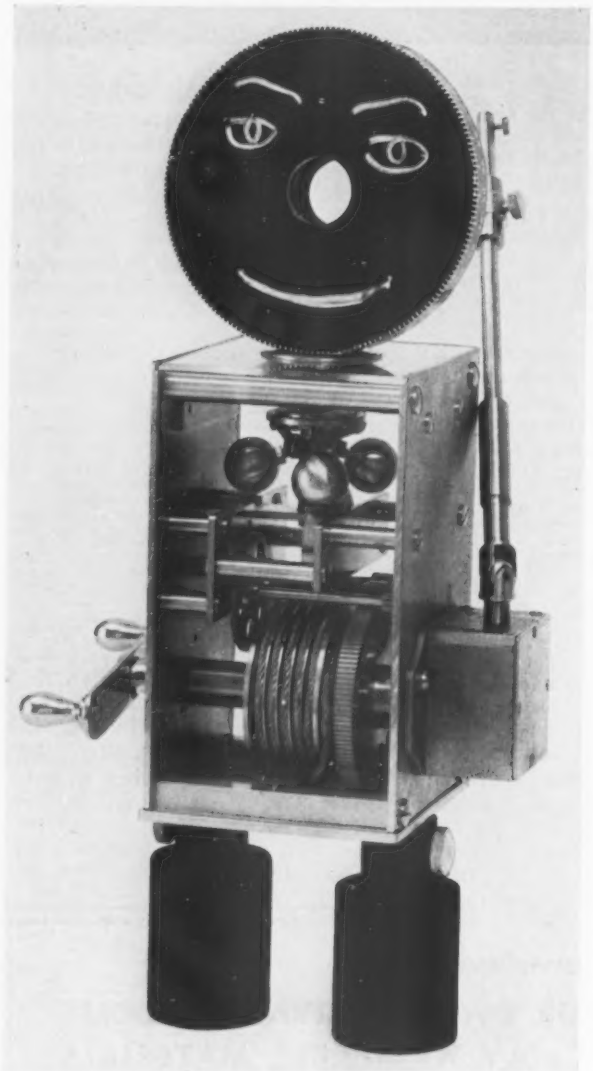
Since the adult scientific world may not be quite ready to appreciate the significance of our discovery, we are presenting it here primarily for the children whose minds are unfettered by conventional ways of thinking. For the benefit of those who may be interested in enlisting the aid of the UNIZOO in their observing, we have added a few technical notes. The UNIZOO cast also includes other characters not shown here. All are illustrated and described—in more conventional manner—in the UNITRON Catalog of Astronomical Telescopes including the Observers Guide which is pictured on the back cover of this issue. It is available free of charge to UNIZOOTHIASTS of all ages.



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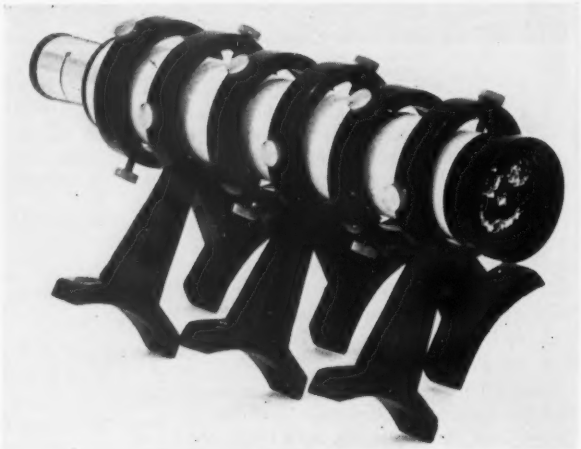
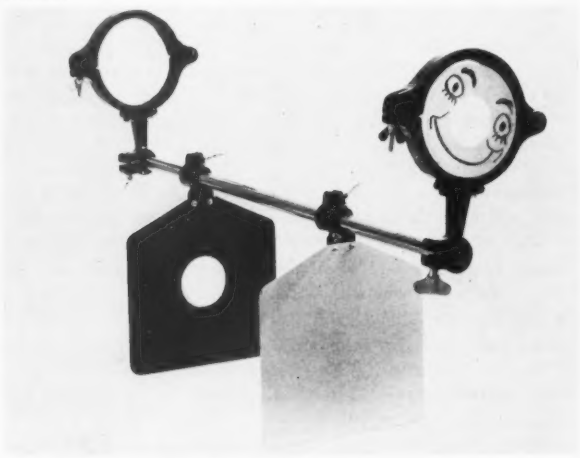
That turns the R. A. drive
More accurately than you can
Even though he's not alive.**

ROBOTRON, like the UNITRON 4" Clock-Driven Equatorial models, is powered by our unique weight drive. His face is a setting circle and his legs are really weights from the UNIBALANCE Tube Assembly.



**Here's UNIPEDE the finder scope.
He lacks power—it is true,
But without his aid you'd have to grope
To bring the stars in view.**

This particular UNIPEDE looks out on the world with a 30-mm. face. His colleagues have 23.5-mm. and 42-mm. apertures. They are priced at $8.50, $10.75, and $18.00 in order of size, complete with two legs, that is, mounting brackets.



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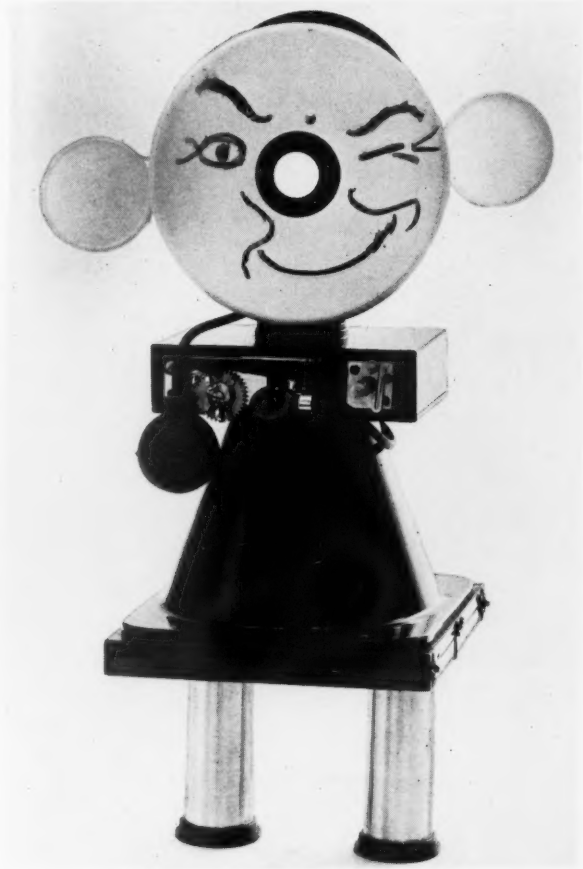
So you the sun may see,
Projected safely on a screen
It's sort of like TV.**

There are SOLATRONS for 2.4", 3", and 4" telescopes which range in price from $12.75 to $15.75. Some have UNICLAMPS so that they may be mounted without drilling holes in your tube. The smile beams from a 2.4" solar aperture diaphragm.

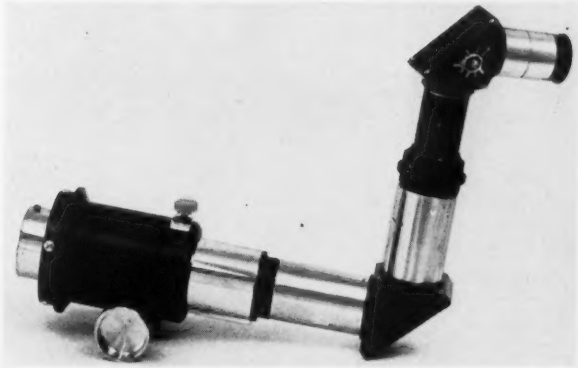
UNITRON INSTRUMENT DIVISION of UNITED SCIENTIFIC CO.
204-206 MILK STREET BOSTON 9, MASSACHUSETTS

A Child's Introduction to Telescope Accessories



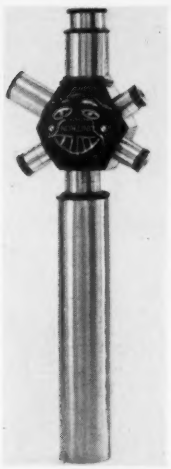
The CAMRATRON was heard to mutter,
"Who said photography's hard?
In my neck I hold a shutter
Invented by Thornton-Pickard."

With the UNITRON Astro-Camera 220, you may photograph at the prime focus of your telescope or, alternately, project an enlarged image on the film. A special 30-mm. e.f.l. projection eyepiece fits into one of the holders which form CAMRATRON's legs. The complete unit with filmholders and accessories is priced at only $69.50. The winking countenance doubles as a two-aperture solar diaphragm.



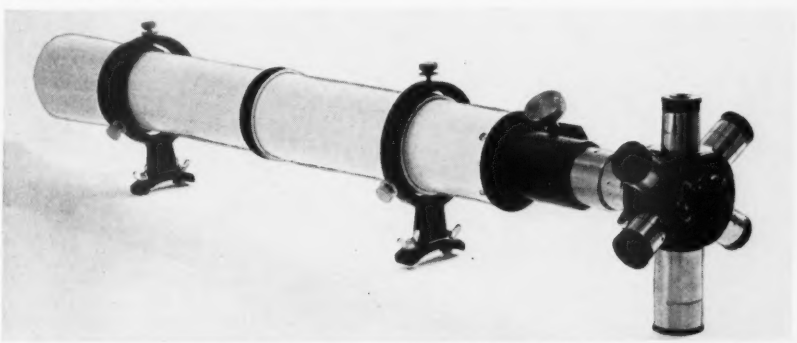
Watch UNIDUCK stick out her neck
As you turn the focus knob.
She didn't have to go to Tech
To learn this important job.

UNITRON "quack"-and-pinion focusing mechanisms are bred in three species: Standard, De Luxe and Super. They range in price from $12.50 to $44.50, complete with drawtubes and eyepiece holders for both 24.5-mm. and 1¼" O.D. eyepieces. The corresponding star diagonals sell for $8.75 and $12.50, respectively.



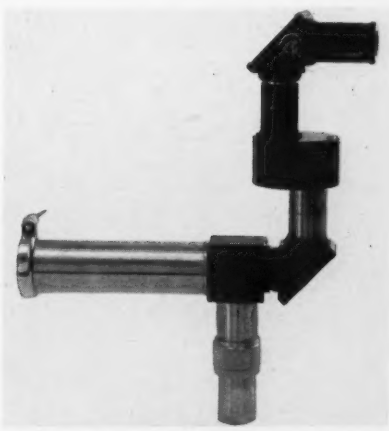
DAISYTRON's powers lie in her brain
(Which is a UNIHEX).
Her figure's really rather plain
Unlike others of her sex.

DAISYTRON, the only botanical member of the UNIZOO, is really much bigger than she looks here. Her head is the massive Super UNIHEX and her torso the large 2¼" diameter drawtube from the Super Rack and Pinion. The top petal is the giant 60-mm. wide-field eyepiece.



The UNIHUND's a "seeing eye."
He's gentle and won't bite.
On your scope he loves to lie
To guide your camera right.

UNITRON's 2.4" f/11 Photographic Guide Telescope is priced at $75.00, complete with crosshair eyepiece, star diagonal, and cabinet. Many have found it handy for general observing because of its compact size. The UNIHEX standard Rotary Eyepiece Selector is available in two versions, each priced at $24.75.



The FLAMINGOTRON—a bizarre bird—
Fulfills no function specific;
A group of prisms, so absurd,
That the light loss is terrific.

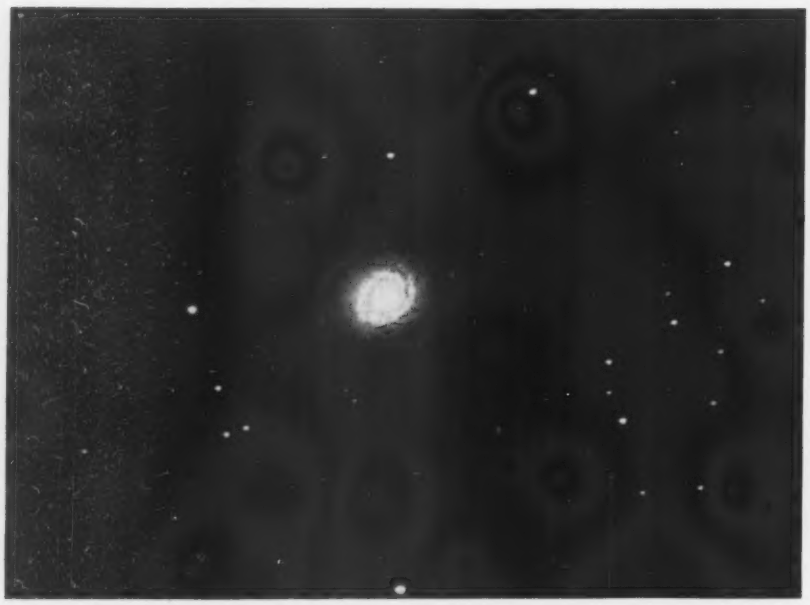
While FLAMINGOTRON as it stands (on one leg) is hardly helpful, the DUETRON Double Eyepiece which comprises its body will permit you to share your telescope with a friend by expending only $23.50. An erecting prism system forms the neck and a star diagonal the head.

UNITRON INSTRUMENT DIVISION of UNITED SCIENTIFIC CO.
204-206 MILK STREET BOSTON 9, MASSACHUSETTS

DEEP-SKY WONDERS

IN MAY we began describing three Messier galaxies that lie in the area between the end of the Big Dipper handle and Cor Caroli, the bright star of Canes Venatici. First there was the Whirlpool nebula, M51; then M63, discussed last month; and now we turn to M94, which is NGC 4736.

Located at right ascension $12^h\ 48^m.6$, declination $+41°\ 23'$ (1950 co-ordinates), this is a slightly oval spiral measuring 5.0 by 3.5 minutes of arc. In amateur telescopes, its spiral structure remains hidden, but it has a visual brightness of magnitude 7.9, while some other Messier objects are as faint as the 11th magnitude. Thus, it is hard to understand why M94 has been virtually ignored as a visual object, unless like M63 it has been overshadowed by its famous neighbor, M51.



The spiral galaxy M94, as recorded with the 36-inch Crossley reflector, in a three-hour exposure on July 4, 1902, by J. E. Keeler, enlargement 3.3 times. South is at the top. Lick Observatory photograph.

As the picture shows, the bright arms of this galaxy are closely wound in an almost round luminous ball. Fainter, somewhat shorter arms are also present, extending into space.

My earliest note on this object comes from a record of 1926, when as a youngster I picked it out with a homemade telescope. The objective was a 1-inch eyeglass lens, a magnifying glass was the eyepiece, and the tube was made of paste-soaked newspapers. But even in this inadequate instrument M94 was clearly seen, and a few nearby stars were plotted on my sketch.

In the Steward Observatory's 36-inch reflector in Arizona, this galaxy is a great glowing ball with the spiral arms pretty clear, but it is curious that the Earl of Rosse with his huge instrument was undecided as to the spiral character.

If the amateur with a small telescope can find M51 and M63, he should try M94, for it is unexpectedly bright and is easier to locate in this rather starless region of the sky than might be supposed.

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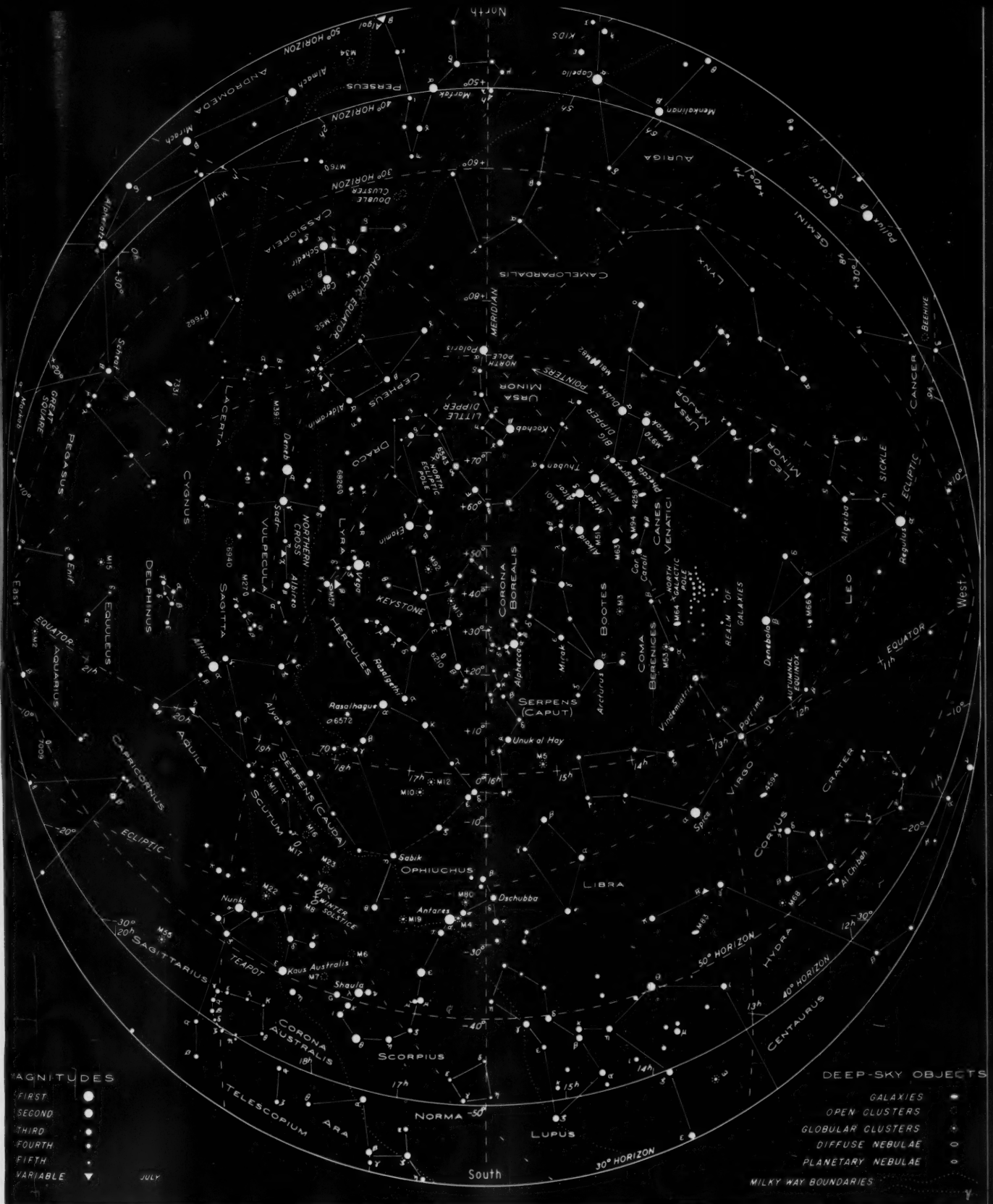
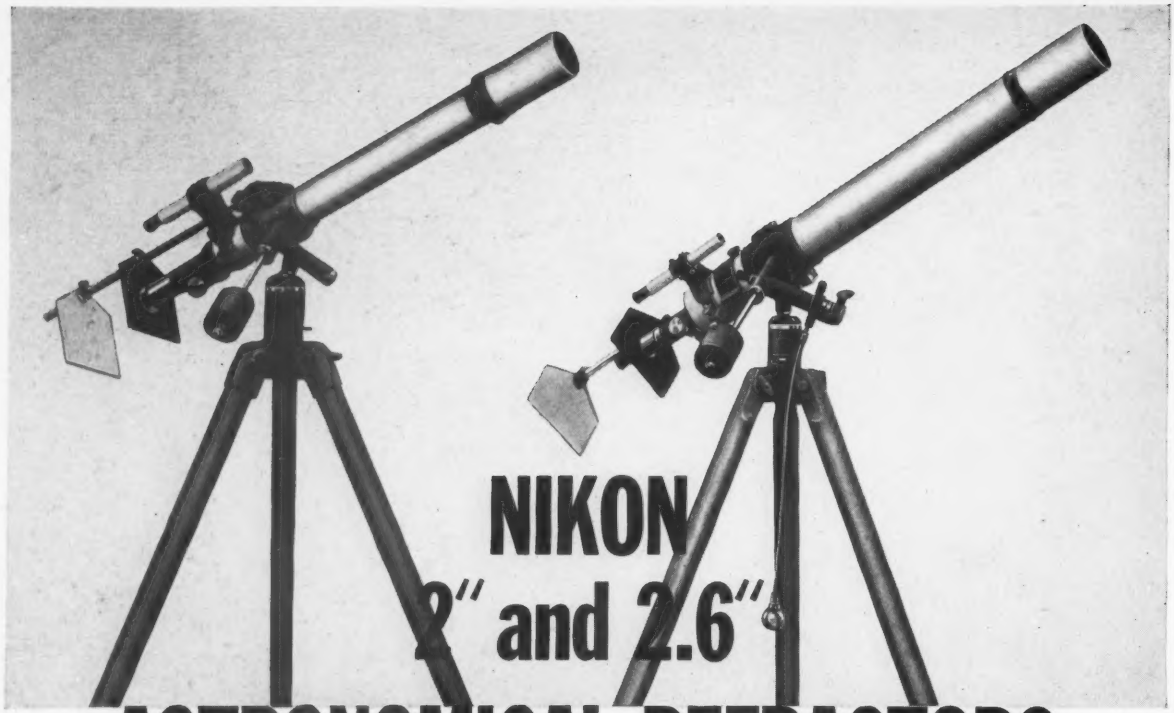


STARS FOR JULY

The sky as seen from latitudes 30° to 50° north, at 9 p.m. and 8 p.m., local time, on the 7th and 23rd of July, respectively; also, at 7 p.m. on August 7th. For other dates, add or subtract ½ hour per week.

Conspicuous in the eastern sky is the Northern Cross in Cygnus, readily recognized by the beginner by means of 1st-magnitude Deneb, at the head of the cross. Look nearby for the arrow, Sagitta, a beautiful compact grouping of comparatively faint stars.



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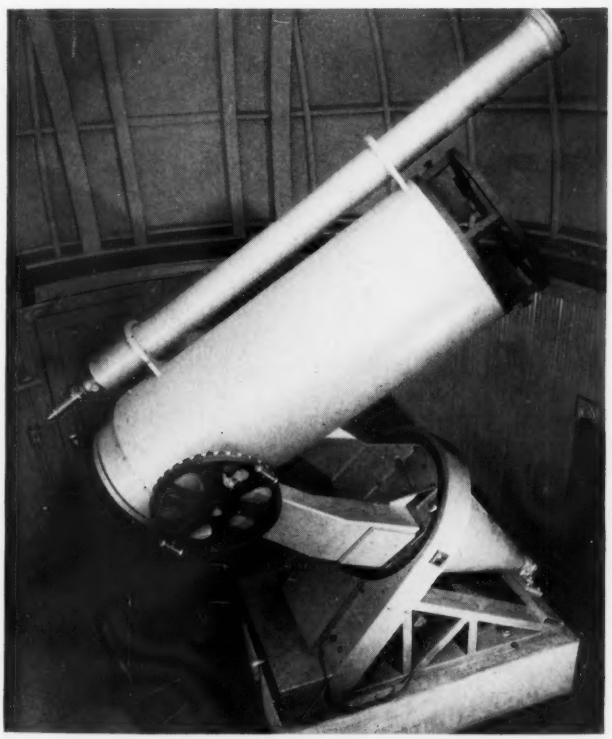

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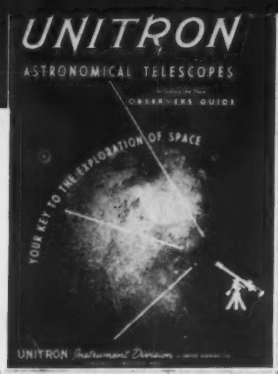

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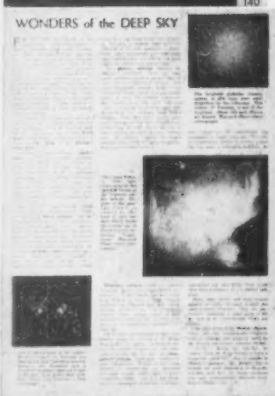

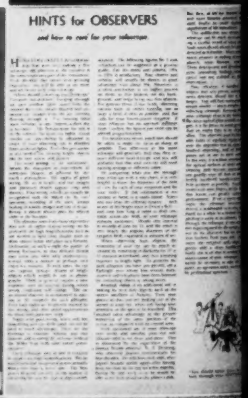

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